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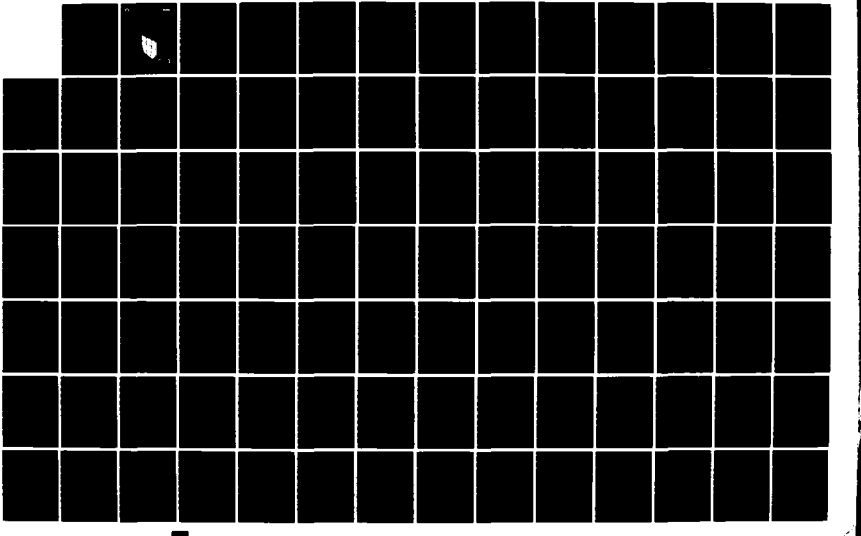

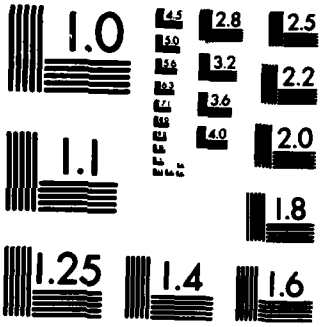

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MICROCOMPUTER SELECTION GUIDE FOR CONSTRUCTION FIELD OFFICES, Updated Edition

by
Michael J. O'Connor
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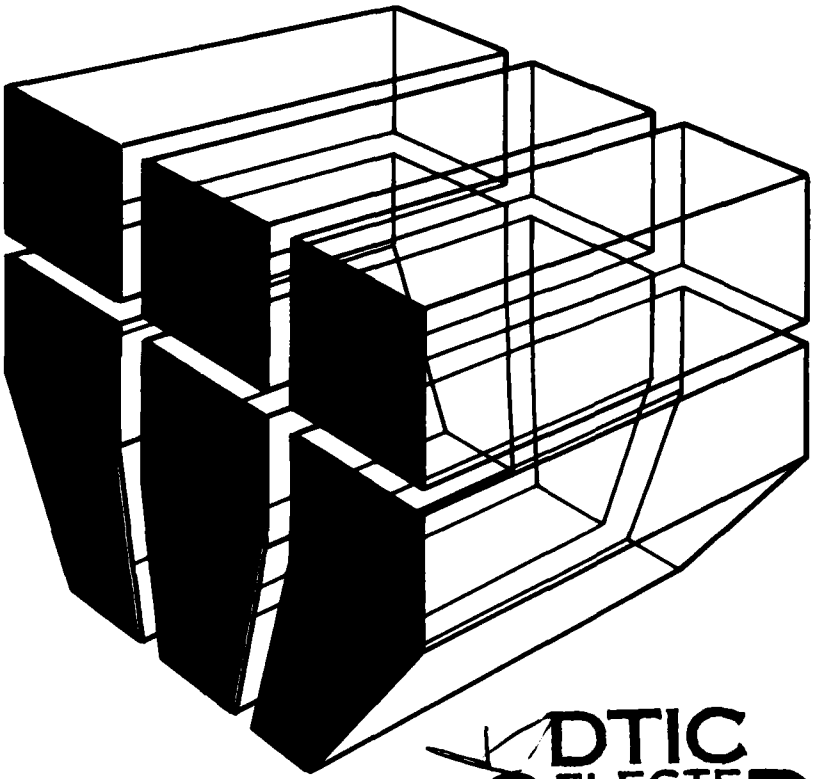

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This guide is designed to help managers at U.S. Army Corps of Engineers construction field offices determine their needs for microcomputer support in their day-to-day operations, and select and procure appropriate systems. The information in this report supersedes that in the 1983 edition.

The guide begins with an introductory tutorial on microcomputers intended to provide managers with the necessary information to make decisions about microcomputers, followed by a review of software packages and examples of

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their use. After a discussion of factors that influence the use of microcomputers in construction field offices, a step-by-step procedure is presented to assess the needs for automation at a specific office. Next, a method is described which will assist the field manager in determining the characteristics of an appropriately sized computer system to meet the needs of his/her field operation. Three general methods of procurement are described: competitive procurement using the Federal supply schedule, competitive procurement using performance specification, and sole-source procurement.

FOREWORD

This work was conducted for the Directorate of Engineering and Construction, Office of the Chief of Engineers (OCE), under Project No. 4A162731AT41, "Military Facilities Engineering Technology"; Task B, "Construction Management and Technology"; Work Unit 037, "Area Engineer Decision Support System." The OCE Technical Monitor was Mr. R. Jaggard, DAEN-ECC-C.

The work was performed by the Facility Systems (FS) Division of the U.S. Army Construction Engineering Research Laboratory (USA-CERL).

This report is a revised version of the June 1983 report. The following individuals provided valuable input throughout the preparation of the initial report: F. Grobler, F. Mabry, C. DeLong, J. Spoonamore, C. Herring, J. Deponai, M. O'Connor, and G. Colwell.

Mr. E. A. Lotz is Chief of USA-CERL-FS. COL Paul J. Theuer is Commander and Director of USA-CERL, and Dr. L. R. Shaffer is Technical Director.

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MICROCOMPUTER SELECTION GUIDE FOR
FIELD CONSTRUCTION OFFICES

1 INTRODUCTION

Background

In 1982 microcomputer technology had progressed to where microcomputer use in U.S. Army Corps of Engineers construction field offices appeared both desirable and economically feasible. In view of increasing workloads, decreasing operating budgets, and the Corps' general responsibility to use available resources more effectively, the new microcomputer provided a most welcome and timely tool. The influx of many microcomputer systems to the market also brought new jargon, intense promotion, and confusing claims. The microcomputer industry was growing so rapidly that it was difficult for those involved in the use of microcomputers to maintain a reasonable comprehension of the industry's direction. Corps construction field office managers, with little time available for studying the microcomputer market, needed help.

To help Corps managers determine where their particular offices and staffs could benefit from microcomputer systems and to assist them in the selection and procurement of appropriate systems, the Directorate of Engineering and Construction, Office of the Chief of Engineers (OCE), asked the U.S. Army Construction Engineering Research Laboratory (USA-CERL) to develop a guide to determining needs, selecting, and procuring microcomputers for construction field offices. As a result of that assignment, USA-CERL published Technical Report P-146, Microcomputer Selection Guide For Construction Field Offices, in June 1983.[1]

The Selection Guide is widely used throughout the Corps; however, microcomputer technology advancement continues at a rapid pace, causing some of the information in the 1983 guide to become obsolete. Consequently, USA-CERL has prepared this updated version of the Selection Guide. The updated version reflects the latest technology and new guidelines by the Corps for use of microcomputers.

Objective

The objective of this guide is to present information on current microcomputer technology and Corps policy. This information is intended to help field office managers (1) determine processes and procedures that can be improved through microcomputer support, (2) select systems that fulfill their needs, and (3) prepare procurement documentation and justification for microcomputer systems.

[1] F. Grobler, M. J. O'Connor, and G. E. Colwell, Microcomputer Selection Guide for Construction Field Offices, Technical Report P-146/ADA-130245 (U.S. Army Construction Engineering Research Laboratory [USA-CERL], June 1983).

Approach

The June 1983 Microcomputer Selection Guide for Construction Field Offices was completely reviewed and all outdated material was removed. New material was introduced as appropriate. The new information was acquired from microcomputer industry publications, members of the Construction Microcomputer Users Group, recent OCE regulations and policy statements, experience with various components, and representatives of microcomputer software, hardware, and peripherals firms.

Scope

Since the distribution of the first Microcomputer Selection Guide for Construction Field Offices, there has been significant progress toward defining requirements, and to some extent translating those requirements into hardware and software acquisitions. This updated guide has the same purpose as the original; i.e., to provide information that will help area and resident engineers planning for office automation to determine their computer requirements and select an appropriate system, as well as help those already automated get the most from their systems and plan for upgrading and/or expanding. With the distribution of ER 415-1-12, Field Office Use of Microcomputers (8 June 1984), certain minimum standards have been established for field office systems. The microcomputer hardware and software described in this guide comply with these minimum requirements.

Outline of This Guide

To procure a microcomputer system, you will need the following information. First, it is important to have a clear understanding of why and how you are planning to use the system. You should be able to show that the planned use of the system will either (1) save money, (2) save time, or (3) improve the quality of work. Second, you should identify which system components are needed and show that they are properly sized to fit your needs. The following chapters attempt to provide you with adequate information to make good decisions. Assistance in selecting microcomputers is also available through the USA-CERL "Small Problems Program." This program is discussed later in the guide.

To serve the reader with little background in microcomputers, the guide begins with a tutorial section on hardware and software in Chapters 2 and 3. Readers with computer experience may start with the action part of the guide, beginning with Chapter 4, and refer to introductory sections only as required.

Chapter 2 presents an overview of microcomputer hardware components and systems. It introduces the terminology used throughout the guide and identifies important features to look for when selecting microcomputer systems.

Chapter 3 introduces systems software such as operating systems and compilers. A number of software packages such as data base management systems (DBMS), spread sheet, and word processing are identified for use at construction field offices and example applications are discussed.

Chapter 4 covers a selection of topics aimed at helping you decide whether a microcomputer system will be useful in your office. Step-by-step guidance is provided on how to conduct a thorough functional analysis of your office procedures.

Chapter 5 details the procedures for selecting a microcomputer system. It explains how to determine which microcomputer system characteristics will fit your office needs, and provides guidance on estimating the system size appropriate for your office.

Chapter 6 deals with the procurement process. Different procurement approaches are reviewed and the documentation necessary to initiate the procurement process is discussed.

The features of the recommended microcomputer system for use in field offices are described in Appendix A. Appendices B through H present detailed information on various topics. They are provided in a sequence that will take the field manager through an orderly progression of activities in selecting a microcomputer system.

Readers who want additional information on microcomputer systems and their applications are referred to the bibliography provided in Appendix I.

This version of the guide also includes an index, which will make it easier for the reader to locate a particular topic.

The intention is to make this guide a living document. USA-CERL will continue to update it from time to time, to ensure that the information remains accurate and current.

2 OVERVIEW OF MICROCOMPUTER SYSTEMS HARDWARE

This chapter is an introduction to microcomputer hardware components. Each major component and its function is discussed, and the desirability of various features is pointed out. An overview of systems' aspects such as reliability, expandability, compatibility, and maintenance concludes the chapter. The reader with a background in microcomputers may skip this chapter without loss of continuity.

Hardware Aspects

Introduction

Microcomputers are designed for use by professionals who do not have a specialized knowledge of computers. However, the selection and procurement of these systems requires careful attention and knowledge of what the different microcomputers and components can do for you. Changes in the marketing strategies of computer and software vendors in recent years have made off-the-shelf microcomputer components and software packages commercially available. This has brought about a significant reduction in cost of computer hardware as compared to the time when large vendors handled turnkey acquisitions. However, the buyer now faces the problem of integrating all these different components.

The problem is compounded by the fact that the computer industry oftens stirs up excitement with product announcements long before the products are marketed. Sometimes performance claims are made which cannot be attained under real-world conditions. The only solution is for the buyer (or an agent) to be knowledgeable and able to ask the right questions. This chapter provides you with the necessary knowledge to understand computer specifications and to ask the right questions.

The components likely to be used in a field office system are indicated in Figure 1, which shows the microcomputer and its peripherals. (Peripherals are the system components which are connected to the microcomputer such as the external storage devices, terminals, printers, modems, and other accessories.)

The recommended configuration consists of a basic system and additional microcomputer work stations linked together via a local area network (LAN). The basic system includes a 16-bit central processing unit (CPU), a monitor and keyboard, a floppy disk drive, a 10-Mbyte hard disk drive, a dot matrix printer, a letter quality printer and the necessary software. (Bits and bytes are explained in detail in the next section.) The additional microcomputer work stations should be configured as recommended in Figure 1 or as specific needs justify. Multi-user systems remain a viable alternative, however a multiple-CPU system allows incremental development of the system to meet specific needs as they are identified. An additional advantage is that a multiple-CPU approach allows the system to be developed over time as funds become available rather than constraining system size or configuration to the current budget. For additional information on the recommended basic system, see Appendix A.

Microcomputers

Despite differences in appearance, all microcomputers include at least a processing unit and a memory unit. Data are processed in the processing unit and stored in the memory unit in the form of bits and bytes. Bits and bytes are explained first as an introduction to the discussion of microprocessors and main memory. A listing of available models of microcomputers is provided in Appendix B.

Bits and Bytes. Digital computers use the binary number system. In the binary system numbers are represented by strings of zeros and ones such as 11001010 (this binary number represents 202 in the decimal system). The binary number system is used because it is relatively simple to manipulate binary numbers by electronic (transistor) switches. These switches can be either on or off, which represent a one or zero, respectively. Each "place" in the binary number is called a BIT (bit = Binary digIT) and can take the value 0 or 1. In microcomputer terminology a group of eight bits is called a byte. A Kilobyte (Kbyte) is 2^{10} = 1024 bytes. Thus, for example, 64K is really 65,536 bytes (64 x 1024). The abbreviation K or Kbyte uses a capital to distinguish it from the decimal prefix kilo. One Megabyte (Mbyte) = 1000 Kbyte. Word length refers to the number of bits in the central processing unit's (CPU's) internal registers. On 16-bit machines two bytes are considered a word.

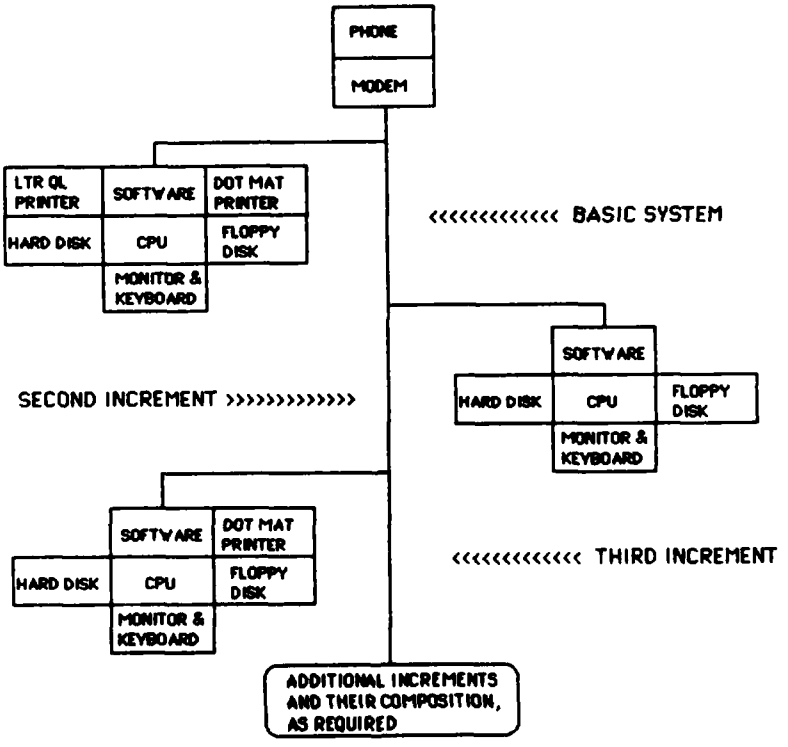

Figure 1. Microcomputer system, incremental build-up. Additional increments and the basic system should be linked via a Local Area Network (LAN). Other items, such as plotters, graphics hardware and software may be included in the initial system or as needed.

Microprocessors. The manipulation of binary numbers takes place in a CPU. The distinguishing feature of microcomputers is that the processors in their CPUs are implemented on micro chips of silicon--hence, the name microprocessors. This distinction between microcomputers and other computers is becoming less clearcut as micro circuits are being used more in all computer systems. Until recently, most microcomputers were 8-bit machines. This means that the width of the data path (i.e., the number of bits that can reach the microprocessor at one time) is 8 bits. The 8080, 8085, Z80, and 6502 were popular 8-bit microprocessors. The 8-bit microcomputer has gone the way of the Model T Ford; it was good in its day, but better things have come along to replace it. ER 415-1-12 recognizes this fact, and does not recommend the 8-bit microcomputer.

Most microcomputers on the market today use microprocessors with 16-bit data paths. The advantage of these processors is that they can handle more information per time interval and are therefore 30 to 80 percent faster. The 8086, 80186, 8016, and Z8001 are examples of 16-bit processors. Another popular processor, the 8088, is unique in having an 8-bit path externally, but internally a 16-bit data path. This allows it to process software designed for both the 8-bit and 16-bit processor. ER 415-1-12 recommends microcomputers with 16-bit microprocessors for use at this time in field offices.

Also available today are microcomputers with 32-bit processors, having either 16-bit or 32-bit external data paths. The Motorola 68000 and the National Semiconductor NS16000 chip families are examples of this technology. Just as 16-bit machines are replacing 8-bit ones, 16s will probably be replaced by 32s in the future. At this time the selection of software available for 32-bit microcomputers is limited. If you have determined that a 32-bit microcomputer best meets your requirements, ER 415-1-12 does not prohibit acquiring one, but the 16-bit is more versatile for most field office applications at this time.

What exactly is software? As stated before, all manipulations of numbers and symbols (data represented in binary strings) occur in the microprocessor. To do useful work, the microprocessor needs instructions of how the data should be manipulated. These lists of instructions, which are executed one by one, are contained in computer programs or software.

As indicated before, the 8-bit microprocessor is currently out of date, the 16-bit microprocessor is the present standard, and the 32-bit microprocessor is coming in the future. Consequently, new software development for 8-bit processors has essentially been discontinued, although a large number of programs are still available for them. Software developers are concentrating on 16-bit programs, and this is where the most advancement, both in quantity and quality, is expected in the near future. Software for the 32-bit processor is emerging, but a reasonable volume is not currently available.

Clock speed, normally expressed in megahertz (MHz), is another concept the prospective purchaser of a microcomputer will encounter. The clock speed is an indicator of how fast each instruction can be processed and, therefore, how fast the microprocessor can execute a program. Common clock speeds for 8-bit microprocessors range from 2 to 5 MHz while common clock speeds for 16-bit microprocessors are between 4 MHz and 12 MHz.

Main Memory. In microcomputers, the main memory is normally provided by silicon memory chips. These chips are solid state devices which allow information to be retrieved very quickly. All or part of a program must be brought into the main memory before it can be executed. Typically, the more main memory available, the faster a program can be executed.

Random Access Memory (RAM) allows the processor to randomly retrieve and store information using an address of the location where the information is stored. This process is analogous to posting or retrieving something from a mailbox specified by a number. An important characteristic of RAM is that it is volatile, which means that all stored data are lost as soon as the power is turned off (or interrupted).

RAM is available in either "static" or "dynamic" form. Static RAM is slightly more expensive, but dynamic RAM needs to be refreshed (recharged) every few milliseconds and this consumes some of the CPU cycles.

Another type of solid state memory used in computers is the Read-Only Memory (ROM). As the name implies, the microprocessor can only read information from this memory. Information has to be written into the ROM by a special process. ROM is nonvolatile and generally used for programs that are repeated over and over, such as those within the operating system. (The operating system is discussed in Chapter 3.) Programs written into ROM are called firmware. Erasable programmable ROM (EPROM) allows the user to erase information using ultraviolet light. Electrically erasable programmable ROM (E^2PROM) was recently introduced. The EPROM is more expensive than the ROM.

Most 16-bit microprocessors can address multiple segments of 64 Kbytes up to a theoretical total of 16 Mbtyes. However, 16-bit microcomputer systems are currently capable of addressing only up to 1 MByte of memory space.

Direct memory access (DMA) is a procedure, available on some microcomputers, which allows data in the main memory to be transmitted to other devices, such as printers, without interrupting the CPU.

External Data Storage

As mentioned before, RAM is volatile; the information is lost when the power is turned off. Some other method of storage is required if the information is to be used again. Also, due to the relatively small capacity of the main memory, it is necessary to have the capacity to store large programs and data bases externally. This kind of storage is provided by external storage devices. The following external storage devices are available: floppy disks, hard disks, digital tape cassettes (called cartridge tapes), and ordinary audio tape cassettes. In small office computer systems the cassette tape devices are mostly used to provide backup storage, while disks are used for "on-line" storage. On-line storage capacity refers to the amount of information which can be retrieved by the CPU without any human intervention such as inserting a floppy disk into the disk drive.

Floppy Disks. Floppy disks or diskettes are thin, flat, flexible plastic disks coated with a magnetic emulsion similar to the coating on audio cassettes. Floppy disks are available in three sizes: a 3 1/2-in. diameter "micro-floppy" disk, a 5 1/4-in. diameter "mini-floppy" disk and an 8-in. diameter regular floppy disk. Depending on how densely a system stores information on the disk, single density (SD) or double density (DD) disk formats may be used. Single-sided (SS) disks can store data only on one side; double-sided (DD) disks can store data on both sides. The component that reads and writes on floppy disks, when the disk is inserted into the device is called a floppy-disk drive. The disk drive rotates the disk at 300 rpm, and stores the information in concentric tracks around the disk. Tracks can be randomly written or read by moving the read/write head radially in or out above the surface of the disk.

The 5 1/4-in. disk has replaced the 8-in. disk as the standard floppy disk among small business computers. While the 3 1/2-in. disk is gaining slowly in popularity, it is not expected to replace the 5 1/4-in. standard in the near future.

The 3 1/2-in. disk stores 400 KBytes of information, 385 KBytes of which is useful information. The term "useful information" indicates the amount of storage available to the user. The system also writes housekeeping information on the disk to enable it to find data when needed, which makes that part of the disk unavailable to the user. The storage space accessible by the user is called the formatted capacity, while the total storage on the disk is the unformatted capacity.

The 5 1/4-in. disk is currently available in several disk formats. A single-sided, single density (SSSD) IBM formatted 5 1/4-in. floppy normally stores 180 Kbytes of data per side. In double-sided, double density (DSDD) IBM format, a disk can store 360 Kbytes of useful information.

Most manufacturers of 8-in. floppy disks have adopted the IBM single-sided, single density format as a standard. The 8-in. floppy can store 250 Kbtyes of information in the single-sided, single density format (SSSD) while the double-sided, double density format (DSDD) has a capacity of over 1 Mbyte of information.

The type of storage devices selected for your microcomputer system can affect how it will be used. It is not uncommon, even with single systems, for the number of accumulated floppy disks to exceed 50 after the first year. Such a large number of disks requires careful management. In addition to access time, storage capacity is another issue. With many large programs it is often necessary to load one floppy, remove it, and then insert another one into the disk drive. Because of the relatively small storage capacity of floppies, they are not considered feasible for heavily used systems; therefore, hard disks are the recommended primary storage device.

Hard Disk. A hard disk or rigid disk, as the name implies, is a magnetic emulsion applied to a rigid aluminum disk. Due to the greater manufacturing precision possible here, the density of the stored data and therefore the on-line storage capacity is increased dramatically. Another benefit of the hard disk technology is that any information can be written and retrieved (access

time) 5 to 50 times faster than on floppy disks. The decrease in access time is due to a disk rotation of 3600 rpm and the high storage density.

When first developed, hard disks were only available as an integral part of the disk drive (fixed disks). Removable hard disks (dismountable disks) are now available. They can be removed from the disk drive and replaced by another disk pack of appropriate size. The Winchester disk format is the most popular for microcomputers. These disks are hermetically sealed with the electromechanical components which read and write. A 5 1/4-in. Winchester disk is normally fixed, but removable Winchester disks were recently introduced. The storage capacity of 5 1/4-in. Winchester disks ranges from 5 Mbytes to as much as 40 Mbytes per disk.

Backup Requirements. Due to the risk of loss or destruction of stored information on any disk, it is necessary to duplicate the information regularly, or copy it to some other storage medium. This process is called backup storage. For multi-user systems, backup storage should be performed a minimum of once a week. It is recommended that you select a microprocessor system with at least one floppy disk drive and one hard disk drive. The ideal medium for backup purposes is the floppy disk. The floppy disk is relatively cheap and can transfer the information back to hard disk in a very short time. Cartridge tapes can also be used to store copied data. Cartridge tapes provide a slightly cheaper storage medium than the floppy disk and are not as cumbersome (e.g., approximately thirty 5 1/4-in. 360-Kbyte floppy disks are required to back up a 10-Mbyte hard disk while only one cartridge tape is required to back up the same 10-Mbyte hard disk). However, the tape machine is more expensive than the floppy disk drive. Audio tape cassettes have a slow rate of information transfer and are not feasible for professional use. A problem with using tapes is that they store information sequentially. Consequently, data elements cannot be randomly retrieved.

Monitors and Keyboards

Work stations normally consist of a keyboard and a TV-like display unit called a cathode ray tube (CRT) or monitor. The keyboard is used to communicate with the system, and the monitor displays information on a video display screen. Microcomputer systems today are available in a variety of configurations. Most standard systems include a monitor and a keyboard. Other systems require the monitor and keyboard to be purchased at an additional cost. Systems with detachable monitor and keyboard allow the user to select any compatible monitor or keyboard to replace those provided by the microcomputer manufacturer. This convenience allows the user to configure a system to meet specific needs or individual preferences.

Monitors are available in both color and monochrome displays. Monochrome monitors are commonly available in a green or amber display on a dark background, or with a white on black background. White on black monitors reportedly cause more eye fatigue, while amber is reported to cause the least eye fatigue.[2] Reverse video displays are also available on most monitors. This feature allows the user to reverse the image and background colors of the

[2]Jonathan King, "VDT: How to Prevent 'Terminal Illness,'" Medical Self-Care, No. 24, Spring 1984, pp 27-31.

screen, e.g., black letters on a white background can be changed to white letters on a black background. The ergonomic design of the terminal is an important consideration. Ergonomic designs allow the user to adjust the position of the monitor and keyboard to minimize eye fatigue and muscle strain.

Most monitors display 24 lines of text. The number of characters per line varies between 40 and 132. Small business systems typically have 80 characters per line. A line width of 40 characters is generally unacceptable for professional use. Monitors with 132-character line widths are becoming more commonly available. Most printers have a 132-character carriage width which allows a document to be printed exactly as it appears on the 132-character monitor. This is especially important for project management systems and systems with graphics capabilities.

Two additional features which are important when using a monitor for graphics are its resolution and refresh rate. The resolution of a monitor refers to the clarity of the display in terms of the number of dots displayed on the screen. The higher the resolution, the clearer the displayed image will be. The resolution of monochrome monitors is generally greater than the resolution of color monitors. A monitor which is being used for graphics will only be able to display the resolution produced by the graphics card sending the image. Therefore, when putting together a system for graphics purposes, it is best to select a graphics board first, then select a monitor with resolution capabilities which most closely match those produced by the graphics board. The refresh rate of a monitor refers to the number of times per second which the image is redisplayed on the screen. The higher the refresh rate, the more times the image is displayed per second; an image that appears more constant reduces eye strain. A monitor should have a vertical refresh rate of at least 55 Hz.

Many work stations offer a variety of user conveniences at a low cost. Detachable keyboards and separate numerical keypads are available on many terminals. Another available feature is programmable function keys. The user can use these keys to do often-repeated functions in one stroke, which otherwise would take several strokes. Special function and control keys should be located away from other keys to prevent the user from inadvertently pressing the wrong key. The keyboard should look and feel like the keyboard of an expensive typewriter. Membrane keyboards, sometimes found on personal computers, are not acceptable in the office as they do not provide the feel of a keyboard.

The work station should support the full character set specified in the American Standard Code for Information Interchange (ASCII). The full character set includes all upper and lower case letters, numerals, punctuation marks, and a few special characters. The ASCII character set is the universal standard for microcomputers. Each character is represented by a 7-bit binary code which fits nicely into the 8-bit byte with one bit to spare for error or parity checking. Other important features for monitors are smooth scrolling, addressable cursor, and highlighting. In graphics monitors, there are more features to consider which will not be dealt with here. A partial listing of monitors and keyboards currently available on the market is provided in Appendix B.

Printers

Printers encountered in microcomputer systems fall into two groups: letter quality printers which print letters to look like good quality typing and high-speed or data quality printers for other purposes.

Letter quality printing normally requires a printer which prints each letter fully formed, but other letter quality printing technologies exist such as laser and ink jet printing. The most common letter quality printer is the daisy-wheel printer, which has the letters located on the ends of the spokes of a wheel. The wheel is rotated to place the required letter in front of the striking hammer. Daisy-wheel printers which print at speeds of 25 to 50 characters per second have the best benefit-cost ratio of this type of printer.

High-speed or data quality printing is normally provided by a dot-matrix printer. This type of printer forms letters using dots made by pins in the printing head. In good quality printers, each letter is formed by a matrix of 9 by 12 or more dots in the matrix. Features commonly available on dot-matrix printers are dual printing modes, programmable fonts and/or pitches, and graphics capabilities. Dual mode printing means that the printer can do both correspondence quality and data quality printing. Data quality is printed at high speeds, typically 120- to 300-characters per second (cps). However, due to the high speed of printing, the dots are not closely spaced. Data quality is suitable for long reports such as CPM network schedules. Correspondence quality is created at a slower printing rate of between 40- to 150-cps. The printer then spaces the dots closer to each other, often by making multiple passes to print each line. Correspondence quality is suitable for internal memos and less formal external correspondence. However, the printing quality of dot-matrix printers is steadily increasing and may soon satisfy all the printing needs in most offices. In the graphics mode, dot-matrix printers can print graphics displays, using up to 144 by 144 dots per sq in.

Inventories of printer supplies should be carefully maintained. Printers consume ribbons and paper supplies very quickly.

Features to look for in selecting a printer:

1. The printer should provide true descenders. For example, in the word "guide" the letter "g" is a descender as its tail extends below the bottom of the letter "u."

2. A tractor feed attachment must be available for continuous fan-fold paper. Friction feed is used to feed single pages through the printer manually as done for an ordinary typewriter.

3. The user should be able to manually set the top of a form, and vary the form length.

4. The printer should be able to use paper up to 14 7/8 in. wide. A listing of some printers available in the market is provided in Appendix B.

Modems

The name modem is derived from MOdulator/DEModulator. This device is used to transform the digital signals it receives from a computer into audio or analog electrical signals. These signals are then transmitted over conventional telephone equipment to a compatible unit at another location. Once the signal has been received, the process is reversed and the second computer can process or display the information.

Microcomputer systems typically transfer data at a rate of 300 baud or 300 bits per second. A rate of 300 baud translates to about 30 cps. For faster transfer, modems of 1200 baud and higher are available.

USA-CERL's experience with using microcomputers on test sites indicates that most field offices would require a 300- to 1200-baud switchable modem which can automatically dial out to specified numbers. Any modem selected for field offices should be compatible with the Bell 103/212A standard and be interfaced to the system via an RS232C port. Modems connected directly to the telephone system, rather than acoustically to the hand-set of the telephone, or modem boards installed in the microcomputer are recommended. Modem boards installed in the microcomputer are the most convenient means for interfacing with the telephone system.

The quality of transmission in telephone lines in some areas is such that special data lines may be required. The local telephone company or computer consultant will be able to advise you on this matter. A list of some modems available in the market is provided in Appendix B.

Local Area Networks

With the increased use of microcomputer work stations throughout the office environment, the need to access or share information between microcomputers has developed. Local Area Networks (LANs) have emerged to provide a medium for information exchange between microcomputers. Although LAN technology is still in the development stages, significant capabilities do exist for systems which have been configured correctly.

An LAN is a network which implements a protocol for controlling the transmission of information between microcomputer devices. Not only does an LAN allow several microcomputers to communicate with each other but more importantly, it provides a means of accessing a central mass storage device or file server which can be attached to the network. By storing files in a central location, this type of configuration provides the data-sharing capabilities of a multiple-user system with the computing power and speed of a multiple-CPU system.

A star topology consists of a central host computer with a different cable connected to each individual device. The host computer controls all communications between each of the connected microcomputers. If the host computer goes down, the entire network is down.

A ring topology consists of a single cable connecting each microcomputer in a continuous loop. In this configuration all messages travel in the same

direction, therefore, a message going to a microcomputer 50 ft away may be forced to go almost completely around the network. This configuration has not been fully implemented yet.

A multiple drop or bus topology consists of a single communications line connected to a host computer and shared by several microcomputers. This configuration is easier and cheaper to install than the others and handles bidirectional communications. The multiple drop topology is considered the state of the art.

The cable or transmission medium used in an LAN can be twisted pair cable, coaxial cable, or fiber optic cable. The twisted pair cable consists of two wires and is capable of transmitting information at speeds up to 1.6 Mbytes per second (Mbps). Coaxial cable is the same type used for cable television, and can transmit information at speeds up to 50 Mbps. Fiber optic cable is composed of glass fibers which use light to transmit information at speeds between 50 Mbps and 140 Mbps. The fiber optic cables can be used on systems of nearly unlimited length, while coaxial cable networks can be a few miles long and twisted pair cable networks only a few thousand feet long.

Each LAN uses a protocol for determining which device is to transmit information at any one time and for error checking during information transmission. The two major protocols used on most LANs today are Carrier Sense Multiple Access with Collision Detection (CSMA/CD) and Token Passing (TP). CSMA/CD works by listening for other users on a line; if none are detected, the message is sent. The transmitted data are checked for garbling; if garbling is detected, the message is either slowed or retransmitted. The CSMA/CD protocol is implemented on networks with multiple drop topology. The TP protocol uses a token message to determine which station on the network can transmit information. Information can only be transmitted by the station having the token message. Once transmission is complete, the token message is passed on to the next station, which can either accept the token if it has information to transmit or pass it along to the next station. TP protocol is most commonly used for ring and star topology networks.

Other important factors when considering an LAN are: the amount of cable necessary to install the system, which will directly affect the system's cost, the maximum number of stations allowed on the network, and the ease and cost of expanding the system. In addition, if several different microcomputers and operating systems are used in your office, it is essential that the LAN be compatible with each system. For a list of some LAN vendors, see Appendix B.

Accessories

Many accessories are available, but only power line filters and backup power supplies will be discussed.

Digital computers are sensitive to changes in voltage and are affected by voltage surges, transients, and interference which can occur in power supplied by utility companies. Loss of data can be the unfortunate consequence. This problem can be minimized by a power line filter. A typical filter costs $100 to $200 and is recommended for <u>every</u> system. Power line conditioners, which not only filter voltage surges but also supplement the power supply if low

voltage is experienced, should be used in areas where large fluctuations in the power supply are common. Line conditioners start at about $500.

If power failures are common in your area, a backup power supply (BPS) or uninterruptable power supply (UPS) should be considered. A BPS is a device which automatically senses a drop in the utility power voltage, and within only a few milliseconds delay, switches to its built-in, rechargeable battery pack. A UPS does not have this short delay. The duration of the emergency power supply can last only long enough to ensure that the system shuts down orderly, or it can last longer than 30 minutes. Understandably, the higher capacity units are more expensive.

It is recommended that field offices in areas which experience frequent power failures include a backup power supply in a system purchase to provide orderly shutdowns. Backup power supplies begin at about $500. Emergency power should be provided only to the computer and storage devices and not to terminals and printers. This will reduce both the amount of energy required from the backup power supply and the cost of the power supply unit. Microcomputer systems should be turned off during electrical storms. A list of vendors of power protection devices is presented in Appendix B.

System Aspects

Physical Environment

Microcomputers function well in physical environments where humans feel comfortable. Their safe operating range is between temperatures of 60° to 80°F. Very low humidity causes static charges which can cause problems. Field offices may find it necessary to control humidity in dry areas or during cold seasons. Antistatic carpets and sprays are available to alleviate the problem. Dust can affect all exposed components of the microcomputer systems. The most vulnerable are the mechanical components such as disk drives and printers. The rule of thumb is that dust will not present a problem under normal office conditions.

The physical placement of the microcomputer and its components will naturally vary among field offices. Cables connecting the CPU to monitors and printers should not be longer than about 40 to 50 ft. If longer distances are required, additional amplifiers, adaptors, or modems will be necessary.

Microcomputers and peripherals use ordinary 120-volt, 60-Hz power supplies. One 15-amp circuit will be adequate for most systems. The use of other outlets on the power circuit should be avoided, especially by devices that operate intermittently such as copying machines, air conditioners, and refrigerators.

Reliability

The mean-time-between-failures (MTBF) is a measure of reliability for microcomputers that is gaining acceptance by computer professionals. Manufacturers rate their equipment in terms of MTBF in hours. Good printers now are rated at 2000 hours MTBF or more. As MTBF information becomes more readily

available and reliable, it can be used to compare the reliability of components of different brands.

Microcomputer components have attained a high degree of reliability, but equipment failure is still a fact of life. An equipment failure can interrupt the daily operations of the field office, causing excessive delays in projects and inefficient use of personnel. Field managers may consider avoiding this by adding backup components to their microcomputer system. If you install two printers, there is a very high probability that at least one will always be functional. Another possibility is to use older, field-proven models rather than risk reliability problems with a new and untested model.

Expandability

The ability to add components and functions to the microcomputer system will be very valuable in most field offices. Components can be added as funds become available or as users discover new applications that were not anticipated before actual hands-on experience.

In selecting a microcomputer system, field managers should ensure that an adequate number of unoccupied I/O (input/output) ports or interfaces will be available for future expansion. A port is a multi-wire receptacle through which various components can be interfaced to the CPU or with each other.

In a serial port, the electrical impulses (bits) which constitute the characters follow each other in the same wire. In a parallel port, the bits which make up each character are transmitted by separate wires in parallel. Greater transfer rates are possible with parallel ports.

Two commonly used ports are listed below:

1. RS232 Port--A serial port used on most systems. RS232 connecting cables can be as long as 50 ft without requiring additional amplification.

2. Centronix Port--A parallel port often used on printers.

Special electronic interfaces are available for converting a parallel interface to a serial interface and vice versa.

Compatibility

This section is concerned only with the compatibility of the various components and with the software you expect to be using in <u>your</u> system. (Compatibility of your system with other Corps systems is discussed in Chapter 4.)

Selection of a microcomputer system must take into consideration its compatibility with other components and available software. Hardware compatibility of microcomputer components depends on factors such as port configurations, bus-structure, protocols, and data transfer rates.

Bus-structure or bus-architecture refers to the configuration of wires used to connect different elements of the CPU and the microcomputer ports. The bus-structure specifies the functions of the different wires. Printed circuit boards can be plugged directly into receptacles on the bus. The modu-

lar, functional construction of these boards makes it possible to add new functions to the computer by adding new boards. For example, you may be able to add color graphics or communications to your microcomputer system by plugging in a new board. The availability of additional slots is also important when considering the expandability of a system.

Protocols, in computer terminology, refer to sets of rules that describe how different components should operate to transfer data.

Another factor that has to be considered in hardware compatibility is the rate of data transfer. The transfer rates of the components must be carefully matched. Since the CPU operates much faster than the peripherals, especially mechanical devices such as printers, some form of "buffering" is normally required. The peripheral equipment should have a memory buffer to store bursts of data transmitted to it by the CPU as well as a compatible protocol to signal when to start/stop sending data.

With the emergence of the IBM PC as the "de facto" microcomputer industry standard, a large portion of the industry is now geared towards supporting IBM and IBM-compatible microcomputer systems. To tap this vast resource of IBM compatible products and product support, a consumer in the microcomputer market must be able to determine which microcomputer products are truly compatible.

True compatibility must address four areas:

1. Operating system compatibility, which results from the differences between PC-DOS (IBM Personal Computer Disk Operating System) and MS-DOS (Microsoft Disk Operating System), is often most crucial. Hardware functions and system calls made by a software package may not produce identical results in both operating systems. Therefore, a software package's performance may be limited if it is run on MS-DOS rather than PC-DOS, or vice versa.

2. Disk compatibility is related to a system's ability to read data from an IBM PC formatted disk. Certain systems, such as the Texas Instruments Professional and the DEC Rainbows, can read data from IBM PC formatted disks, even though they may not run software written for the IBM PC.

3. Data compatibility refers to a system's ability to accept data which is electronically transmitted to it from the IBM PC. To be considered "data-compatible," a system need not be capable of running software written for the IBM PC or of reading IBM PC formatted disks.

4. Hardware compatibility concerns a system's ability to accept hardware constructed for the IBM PC, such as IBM expansion cards and peripherals.

To further complicate the problem, there can be varying degrees of compatibility within each of these four areas. To claim compatibility with the IBM PC, a microcomputer should satisfy criteria of each of the four areas.

The performance specifications for your components should specify not only the component's desired characteristics, but should also indicate other system components with which it must interface. The burden of making the system work should be placed on the vendor. Corps users should avoid (unless

you are thoroughly knowledgeable about the products) buying individual pieces and expecting to see them work by merely plugging them together.

Security

When more than one person has access to the same computer, sensitive information might be accessed by persons for whom it was not intended. Fortunately, most systems that allow multiple users offer some system of security. In simple security programs, computer files can only be unlocked by some password. More elaborate security programs provide many options such as allowing an individual access to read, but not to change or add to specified files.

Warranties, Service, and Maintenance

In selecting and acquiring a microcomputer, field managers should pay careful attention to maintenance requirements of the system. The decision to purchase a specific microcomputer should be based on the total life-cycle cost which includes the cost of service and preventive maintenance.

Most warranties for computer hardware run for 90 days from the date of purchase. During this time, the vendor will normally perform all repairs free of charge. You may be able to use your leverage as a potential buyer to negotiate an agreement which states that if any component fails, a full 90 day warranty is resumed upon its repair. In most cases, the defective component must be taken to an authorized service center. Some manufacturers offer an exchange service for defective boards. To take advantage of this service, someone in your office has to be knowledgeable enough about the microcomputer to determine which board to send away.

After the warranty period, a variety of servicing options are available. Manufacturer or vendor servicing, authorized service centers, independent service shops, and national third party service organizations are the options to be considered.

Vendor Servicing. Vendor servicing for microcomputers is not common. Some of the exceptions are Radio Shack and Digital Equipment Corporation (DEC). Vendors normally have an annual charge of between 10 and 15 percent of the purchase price for carry-in service. Onsite repairs cost between 20 and 25 percent of the purchase price. Vendors may include a surcharge on mileage above a specified maximum. It may be uneconomical or impossible to get vendor service in remote areas.

If you opt for vendor servicing, you probably depend heavily on the computer and cannot afford to be inoperative. You should try to write into your service contract a time limit in which the defective item should be repaired or replaced. Many vendors claim they will respond within 24 hours, but make no positive statement about fixing the problem.

Vendor Authorized Service Centers. Some vendors, such as Apple and IBM personal computers, rely on authorized dealers to provide routine repair service on carry-in basis. More complicated repairs are handled at regional service centers. Consequently, field managers may find it difficult to get onsite maintenance.

Some vendors charge a flat fee rather than a percentage of purchase price. Either way, the cost translates to approximately 10 to 20 percent of the initial purchase price per year of service.

National Service Organizations. Third party maintenance organizations are becoming more popular among owners of microcomputers. These organizations specialize in the service of the computers and peripherals and are represented throughout the country.

The General Services Administration (GSA) has negotiated a Multiple Award Schedule Contract (FSC Group 70, Part 1, Section C Schedule) with many national service organizations to supply microcomputer maintenance to the Government at a substantial discount. For additional information on obtaining maintenance through a contractor on the GSA schedule, see Appendix F.

Third party service organizations often base their service contracts on mean-time-between-failures.

Independent Service Centers. If you have to rely on an independent service center, be sure to inquire about its reliability and other pertinent factors by asking for referrals from other customers. In negotiating a service contract, make sure you understand the cost of the contract (it may be stated in a number of obscure ways), and you are satisfied with the response and repair time provision.

Some Corps automatic data processing (ADP) coordinators feel that computer procurement contracts should include maintenance. However, forces in the marketplace for microcomputers appear to favor independent service organizations. These service organizations allow the field managers to select the best microcomputer components the market has available, and still be able to obtain service readily. The most ingenious and cost-effective microcomputer systems often include components from different vendors, which makes vendor service impractical. Since most integrators of microcomputer systems are not organized to provide service, separate service contracts with third party service organizations often provide an attractive and sometimes the only affordable solution to the service problem.

Appendix E contains examples of the cost of maintenance contracts.

3 SOFTWARE

This chapter reviews software packages which are likely to be useful in construction field offices. These software packages include project management systems, word processing software, electronic spreadsheets, data base management systems, and communications software. Important features are discussed and example applications in the field office setting are described. The chapter concludes with a discussion of software maintenance and user training. Although the software packages are presented at an introductory level, even the informed reader may benefit from the discussion of desirable features and field applications of the software packages.

Introduction

At least two functional levels of software exist. At the higher level, the applications programs are used to manipulate data in some way. The applications program may be a simple routine to calculate area from given coordinates, or it may be a sophisticated word processing program. At a lower level are the operating system and compiler programs.

Software is a very important part of the computer system. One of the golden rules in selecting a computer is to select your software programs first, then find equipment to run them on. This section introduces some important software concepts and reviews a number of types of software that will be useful in field offices. Appendix C contains examples and some details on commercially available software packages.

The following "laws of buying computer software" are somewhat pessimistic, but may be useful to point out that a certain amount of skepticism is necessary when assessing manufacturer's claims of software performance.[3]

1. If you didn't see the program do it--it probably can't do it.

2. If you didn't see the program run on your type of equipment--it probably can't.

3. If you didn't actually see the program run--it probably doesn't exist.

Software Requirements

Software used in field offices should have the following features:

1. Interactive--The usefulness of microcomputers in field offices relies partly on having interactive software available. An interactive program allows the user to communicate with the program during its execution. For example, when inputting a CPM network, the computer checks the information for

[3]Timothy C. O'Connor, "Computers: The Ins and Outs of the Purchasing Contract," Civil Engineering/ASCE, Vol 53, No. 2 (February 1983), p 39.

consistency and feasibility. If an error is detected, the computer identifies the error and the user can immediately correct it. Batch processing, on the other hand, attempts to process the complete input file before a report is printed. Even a minor error in the input can render the results useless and the processing time wasted.

2. User Friendly--The user friendliness of software is a measure of how convenient and easy the program is to use for individuals without special training in computers. The input of user-friendly packages should be in a free format. In interactive mode the user should fill in the blanks on the screen with information as opposed to entering the information into fixed fields of format as on computer cards.

3. Menu Driven--Programs are menu driven when they allow the user to select the command from a list displayed on the CRT. This is convenient for the inexperienced user since it avoids having to remember complicated computer commands. The option to skip a hierarchy of menus is useful to the experienced user.

4. Multi-User--The software should allow more than one user to work on the system simultaneously.

5. Multi-Tasking--The system allows more than one program to be executed at the same time using a foreground/background mode. For example, while a long critical path method (CPM) program is executing in the background mode, a word processing program can be used in the foreground mode.

6. Integration--An integrated system allows one program to pass information through to another program for further processing. Integration is usually achieved through the exchange of ASCII files. The power and utility of the system is greatly enhanced when the different software packages are integrated. Chapter 4 elaborates on the integration of software for field offices.

Operating Systems

The operating system is a program which instructs the machine on how to do its assigned tasks. As an example, the operating system will instruct the system how to write and retrieve files on disk or how these files can be named and copied. In a multi-user system, the operating system must also manage the access of the users to resources of the system.

Applications programs often have to rely on the operating system to get something done (get information from disk, for example). The operating system acts as an intermediary between the application software and the hardware instructions. This proves to be very handy because there is little standardization in hardware instructions. When two computers of different brands use the same operating system, they appear to applications programs as the same type of machine. The ability to use programs on different types of machines is called portability.

Anyone expecting to purchase a microcomputer at this time will be looking at 16-bit or 32-bit microprocessors. The 16-bit machines should have either MS-DOS or PC-DOS and CP/M-86 or a version of the UNIX operating systems. CP/M-80 for systems with 8-bit co-processors is optional. The 32-bit microcomputers should have the UNIX (or some version thereof) operating system.

Compilers and Interpreters

Compilers are programs which translate applications programs written in higher-level languages such as FORTRAN, BASIC, or PASCAL, to a list of instructions which the microprocessor can execute. Interpreters fulfill the same function in interpretive language programs where instructions are translated and executed one at a time.

If you plan to develop any programs in-house, it will be necessary to include a compiler in your buying list.

Project Management Systems

The project management systems (PMS) are based on activity network analysis and need no introduction in the engineering and construction community. The most desirable and important features of a PMS are discussed below. It must be pointed out that PMS for microcomputers have not yet reached the full sophistication of timesharing programs on large computers. Nevertheless, they can perform most of the functions listed below. More sophisticated systems are more expensive--the objective in selecting a microcomputer PMS is to find the proper balance between the cost of the PMS and the requirements of the field office.

1. Network Input. Ideally the PMS should be able to accept input in I,J notation as well as precedence notation. Most lower priced systems accept only one of the two notations. Precedence notation is gaining in popularity, and the Corps should be able to monitor contractor schedules presented in precedence notation. The nodes or activities should be accepted in any order without a restriction on the numbering scheme such as $I_n<J_n$. This makes full-loop detection necessary. The system is assumed to be interactive and menu-driven without any further comment.

2. Variable Calendars. The user should be able to specify time constraints into the PMS such as the work week, any and all holidays, or planned shutdowns. The PMS should be able to start the project on any day of the week. It may sometimes be necessary to assign different calendars for individual activities. This situation can occur when one craft or subcontractor is working overtime while others are not.

3. Level of Detail. It is difficult for field managers to conceptualize or handle a network of more than a few hundred activities. Large or complex projects need to be broken down into multiple networks at different hierarchical levels. This scheme is known by different names--fragnets, hammocking, or super/subnetworking. If this scheme is used intelligently, it is possible to break down a complex project into different levels of detail with a convenient number of activities in the controlling network. The important require-

ment here is that the microcomputer system should be able to automatically pass information on time, cost, and resources from subnetworks to supernetworks, and vice versa. The system should also allow for constraining events (milestones) to occur on, before, or after a specified date.

4. Updating. Since progress reporting is a major reason for using CPMs, it is necessary that networks be updated in the most convenient manner. Only the changes to changed activity parameters--which include duration, completion status, and cost--should be required; re-entering unchanged information should not be necessary. The system should also be able to generate reports from the updated network to indicate percentage of completion and monthly payments due. The system should be able to provide cash flow diagrams and to calculate projected cost and completion time of activities using the observed rate of expenditure of dollars or resources.

5. Evaluation of Schedule Changes. The PMS should allow the field manager to evaluate the impact of any proposed changes to the schedule. The important requirement here is that only exceptions or changes should be highlighted in the impact report. Using this report, the field manager can evaluate the proposed change orders and determine the impact of such changes before giving the notice to proceed. The user should also be able to ask "what if" questions such as: "What if we don't approve shopdrawing X before the 15th of next month?"

6. Report Generation. When using a PMS, one should not have to look at reports longer than a few pages. One of the distinguishing features between a good and average PMS is the capability of their report generators. The report generator should be able to sort and select activities using relevant activity attributes. These attributes include the activity number, character code, duration, float, status, cost, date, and duration.

Intelligent use of the alphanumeric character code will significantly increase a PMS report generation capability. These character codes may be used for identifying and later selecting attributes such as area, subcontractor, and floor for inclusion into the report. The example in Figure 2 shows one possible scheme for using a six-character code.

```
X    X X  X    X    X
.    . .  .    .    Security code
.    . .  .    Method of payment
.    . .  Management identifier
.    . Sub-phase identifier
.    Area/phase identifier
Division identifier
```

Figure 2. Sample six-character alphanumeric code.

Selection based on time segments should also be provided. This is normally referred to as windowing. Windowing allows the user to "zoom in" on a specific time period of interest such as the upcoming week or month.

7. Graphical Output. A schedule presented graphically is much easier to comprehend than pages of activity names and numbers representing starting and completion dates. Many PMS packages can now draw networks on dot matrix printers. Windowing will prevent unnecessarily large printouts. The Gantt bar chart, which is conveniently used by nonengineering staff, is also available on better packages. A newer development to watch for is the Fenced bar chart. This graphic is a time-scaled bar chart with the precedence logic indicated by "fences" between preceding and following activities.

Additional useful graphical reports which should be provided in a PMS are cash flow curves, earned value curves, and resource allocation profiles.

8. Execution Speed. A CPM-based PMS is computationally intensive and normally requires relatively large amounts of CPU time. Due to different strategies followed by the programmers, the execution time for the same network run on different PMS programs can vary significantly. Processing time becomes more important to those offices having many contracts using network analysis schedules. Many PMS programs, running on 16-bit microcomputers, execute a typical 500-activity network in 5 minutes or less. However, some programs may require 1 hour or more to execute the same network. Program cost is not necessarily an indicator of processing speed.

9. Cost/Performance Tradeoff. The best and most sophisticated PMS packages are expensive. The tradeoff is generally in the flexibility and reporting capability of the package. Several PMS packages suitable for Corps use are available at a cost between $1,000 and $3,000.

Electronic Spread Sheet

The electronic spread sheet is analogous to the accountant's spread sheet. A spread sheet is a sheet of paper with columns and rows. The electronic equivalent provides you with a large number of columns and rows. As many as 256 or more columns by 8192 or more rows are provided on 16-bit computers. Only a portion of the spread sheet is actually displayed on the CRT at any one time.

Each cell on the electronic spread sheet can take on a numerical value, heading or comment, or a formula which can refer to the contents of other cells. The computer automatically keeps the entire spread sheet consistent. For example, if one number is changed in one cell and that information is used by another cell, the other cell will automatically be updated. The beauty of this tool is that the computer does all the time-consuming calculations.

Word Processing

Word processing may invoke thoughts of dictated material sent to a word processing center. In this case it is a software package which allows you to process your own letters and reports rapidly and efficiently. Word processing programs manipulate text and allow the user to compose, edit, and format text conveniently. Standard forms and letters can be composed, kept on-line, and instantly retrieved when needed. One area office in the Corps uses over 120 standard forms and letters.

At Corps field offices, word processors have been used mostly by secretarial staff. Some professionals in commercial firms have found it more efficient to word process letters less than two pages themselves rather than dictate them to secretaries.

In addition to a number of "standard" features, word processors should have the following features:

1. Screen oriented--A screen oriented word processor shows the user on the CRT exactly how the text will look when printed out.

2. Easy commands--The word processor should use an easy and consistent command structure.

The following two features are useful, but may be available only on more sophisticated packages. These packages may have complex command structures.

3. Error recovery--some word processors offer an "undo" command which reverses a previous command. This can be used, for example, to recover a line or a file which was deleted inadvertently.

4. Split screen--This feature allows the user to view two documents simultaneously.

Data Base Management Systems

Data base management systems (DBMS) probably do more to make microcomputers useful in construction administration than any other group of software packages. To explain, let's first define a data base. The term data base simply refers to a collection of data elements stored in the computer system.

Keeping track of how elements within the data base are actually stored and retrieved has always been a laborious and complex task for programmers. A DBMS is a program that performs this function. It allows the user to reference data by the name of the data element rather than by the location at which it is stored.

Once the tables and input formats are specified, the DBMS can edit input for correctness, and use the data base to prepare reports in any number of specified ways. An element of information needs to be entered only once, thus saving labor and storage capacity. The DBMS permits different applications to use the same data.

The DBMS can be used in the following way. The basic information pertaining to submittals can be recorded in a submittal register. The input is interactively entered into the system using the keyboard. The computer checks the data as it is entered. The submittal module may be used to print a variety of reports. Reports could also be designed to produce very specific information such as all submittals that have been under review for over 2 weeks or all scheduled submittals that are delinquent. (Note that before the DBMS can perform such functions some DBMS programming will be necessary--i.e., define the function, formats, and reports to the system.)

DBMS vary in degree of sophistication. The most sophisticated of these are relational or hybrid/relation DBMS. These systems are available for microcomputers for less than $700. Less sophisticated systems, often called file handlers, are simpler to use and are less expensive. However, file handlers do not provide the same capabilities as the more sophisticated systems. With file handlers, data can be retrieved only in specified ways; therefore, it becomes necessary for the prospective user when initiating data files to think of every possible way the data will be used. This is very limiting, since users often discover new needs and better ways of doing things after using the system for some time.

The flexibility offered by relational DBMS will be of great value to construction field offices in spite of the greater complexity. (If necessary, relational DBMS can be configured to "look like" simple file handlers for initial applications.) The degree of experience required to use DBMS software varies with the product. Some DBMS programs have help routines, program generators, and screen display editors available to aid the user. Generally, some prior experience or training will be necessary to develop DBMS application programs. The use of previously developed DBMS application programs to record and retrieve information is not difficult and can be learned by persons without prior experience in a short training session.

Graphics Software

Graphics software packages are available and recommended for the construction field office system. They allow the creation of graphs, bar charts, pie charts, etc. from information stored in a data base. Some can also facilitate the production of transparencies useful for briefings, brochures, etc. Other useful programs include statistical analysis and modeling packages for performing "what if" analyses.

When selecting graphics software one should not only be concerned with the type of charts a package is able to create but also with file compatibility and the ability of the software to drive a specific printer or plotter. File compatibility refers to the graphics software's ability to accept standard data files from other software. The graphics software selected should at a minimum be compatible with the files created by the electronic spreadsheet and database management software used in your office. In order to produce hard copies of the charts created by graphics software, the software must be able to drive the printer or plotter with which it will be used. Most vendors supply a list of output devices (printers and plotters) which their software will drive.

Integrated Software

The software packages discussed up to this point have been stand-alone packages with a single purpose. Integrated packages offer access to a combination of software functions through one program, e.g., an integrated package may allow the user to access electronic spreadsheet, database management, word processing and graphics capabilities from the same program. Two approaches to

software integration are emerging on the market. The first approach to integrated software was to take existing software packages and develop an "integrator" package. The integrator software provided the interface necessary to share data between the individual stand-alone packages being integrated. The more recent approach has been to develop a truly integrated package by starting with a single software package, such as a spreadsheet, and developing additional capabilities for the package. The result of this approach is a single software package capable of a wide variety of functions which may include spreadsheet, data base management, and word processing capabilities.

Integrator software merely provides the ability to exchange information between stand-alone single purpose applications software within a single program. Integrator software often uses windowing, a technique whereby the display screen can be split into "windows," each displaying an application package. The major advantage of this type of package is that the user maintains the sophisticated capabilities available in stand-alone applications software. A significant disadvantage is that it requires the user to be familiar with the different commands for each application package.

Truly integrated software packages offer the user all of the major applications in one program, i.e., one package may offer spreadsheet, database management, word processing, graphics, and communications capabilities. This type of software provides all of the major features desired for each application and the convenience of a single command structure. A significant disadvantage of this type of integrated software is that in development of the package a trade-off occurs between required memory size and advanced capabilities. A finite amount of memory is available in any microcomputer; therefore, the size of programs written for the system will be limited, reducing the number of program features.

To help overcome this problem, integrated software manufacturers have based their software on a specific type of application, giving it the full features, then developing the additional type of applications around that with reduced features. When selecting an integrated package, determine what you want the major application of the software to be: e.g., spreadsheet, database management, or word processor. Once this has been determined, an integrated package developed around the selected application can be chosen, thus providing the most features where they are needed. For a list of integrator and integrated software packages, see Appendix C.

Communications Software

The purpose of a communications program is to perform the protocol processing and conversion necessary to allow the transfer of data between computers. The communications program must be compatible with your microcomputer, your modem, and the modem, communications program, and computer with which you wish to communicate.

Several communications packages are commercially available. However, many are limited by unique protocols. Transfer of files, with error checking, between microcomputers requires that the same protocol be used by both communications packages. Commercial communications packages often run on a limited number of microcomputers; however, a public domain program, Modem 7, does run

on many different microcomputers. In addition, Modem 7 compatible programs have been written for Corps' Harris computers and other operating systems such as UNIX. ER 415-1-12 recommends the use of communications software using the Modem 7 protocol to facilitate communications between microcomputers within the Corps. Modem 7 uses the Ward Christenson or xmodem protocol. Although Modem 7 is not yet widely available for 16-bit microcomputers, there are currently a number of commercially available communications software packages which implement the xmodem protocol.

Other Software Packages

There is a rapidly growing number of very useful software packages in the marketplace--too many to identify here. Utility programs that make the computer easier to use are available at very reasonable prices. For example, instead of having to remember a series of obscure commands to access a file, the user has a menu displayed from which the desired file is picked.

Software Maintenance

The purchase of microcomputer software only gives you the right to use the program under the terms of a license agreement. That agreement usually provides for an initial period (usually 30 to 90 days) after purchase during which the vendor will provide free debugging and/or upgrading. Various arrangements are available from software vendors to allow licensees to obtain subsequent enhancements/upgrades. Some periodically recall licensee's disks for upgrading and return, for a nominal fee; others furnish upgraded disks periodically, for a fixed annual fee. In any event, software maintenance costs should be weighed against the market price of the software program. There is also some advantage to remaining uncommitted to one vendor for too long a time, so if new and better products become available from another vendor one would not be reluctant to take advantage of them. One wants to be in a position to use the best software the industry has to offer for a given purpose, whether through a software maintenance agreement, or through shopping the entire marketplace.

License Agreements

Accompanying the widespread use of microcomputers is the use of a vast array of software packages. Software packages are marketed through a variety of methods ranging from developers to retail stores; however, most major packages are licensed by one means or another. The license agreements vary. Some packages license the software to the purchaser while others license the software to the microcomputer on which the software will be used. The latter type of software licensing agreement means an individual software package must be purchased for <u>each</u> microcomputer. Passing copies of a software package between microcomputers within an office <u>is</u> a violation of this type of software's licensing agreement. Packages licensed to individual purchasers may be used by <u>that</u> individual on any compatible microcomputer.

Training

How can one ensure the successful implementation of a computer system? What are the necessary ingredients? People and the will and determination to make the system succeed are the most important factors. Such an attitude often depends on a good training program, or as stated by McClean, "the success of a decision support system is directly related to the amount of education expended on its behalf."[4]

Many well-designed software packages including word processors, DBMS, and PMS guide the user with screen menus and help routines. It does not take the average professional without a computer background long to master the fundamentals of these packages. However, training programs will instill user acceptance and confidence quicker, resulting in shorter learning periods and higher productivity. Without training, the user often learns and continues to use only the most basic functions of the system.

More important, training helps the user to think differently about how to do his or her job. Once the user understands the system's capabilities, he/she devises new and more efficient ways of doing the job (and soon the user wants even more sophisticated capabilities).

Users will take several months to become fully proficient with the system. Although it may be justifiable for economic reasons to replace the system with a newer and better one after 2 or 3 years, the "user inertia" may dictate otherwise. The cost of training and retraining (when key personnel are transferred) is significant and should be included in the life-cycle cost of the system.

How is a good training program located? Most vendors of the more expensive turnkey systems offer training. Unfortunately, this is seldom the case with the lower priced, off-the-shelf software packages aimed at the microcomputer market. Management consulting firms are emerging to provide this service. When acquiring their services you should use only those training courses specifically geared towards your software packages and hardware system. If you don't have in-house training capability, training may also be available from private consultants and universities.

Another possibility is to make training a requirement of the procurement contract. However, this tactic tends to make the procurement unnecessarily expensive and limits the number of possible bidders, especially for the purchase of a small number of systems. Training is an example of the tradeoff between (1) the convenience and high cost of dealing with one-source turnkey procurement, and (2) the flexibility, lower cost, and inconvenience of dealing with off-the-shelf packages.

At this time it seems the best solution is to coordinate training on a district- or division-wide basis. The Southwestern Division, where close to 200 small Apple computers are installed, set an example in this respect. The

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[4]E. R. McClean and T. F. Riesing, "Installing a Decision Support System: Implications for Research," Decision Support Systems: Issues and Challenges, edited by G. Fick and R. H. Sprague, Jr. (Pergamon Press, 1980), pp 127-141.

division has a permanent support group consisting of four to five professionals who provide training at field sites and at the division office in Dallas.

USA-CERL has established a Construction Microcomputer Users Group (CMUG) to provide a forum to discuss common problems, and to exchange ideas and information related to the selection, acquisition, and use of microcomputer systems. The CMUG meets every 6 months, with a current membership of approximately 135 persons. Anyone interested may become a member and attend the meetings. Specific dates and places for CMUG meetings are announced in the Construction Micro Notes, a newsletter concerning microcomputers, which is published by USA-CERL three times each year. USA-CERL is also serving as the clearing house for Corps-developed applications programs. Currently there are approximately 40 programs in the applications library.

The CMUG, the Construction Micro Notes, and the Applications Library are vehicles for getting the latest information on microcomputers spread Corps-wide. The emphasis is on providing the Area/Resident engineers with the information they want and need to know about the use of microcomputer systems in construction field offices.

4 FIELD USE OF MICROCOMPUTERS

The first section of this chapter is a general discussion of construction office functions that can be supported by microcomputers. Example applications are presented to serve as a springboard for your own functional analysis. Strategies for successful implementation are reviewed and a few comments about standardization are made. The remainder of this chapter describes the most important step towards computerization--the functional analysis.

It is recommended that this chapter be read by anyone considering the use of a microcomputer in a construction office.

Introduction

The preceding chapters introduced the hardware and software components of a microcomputer system. The question this chapter addresses is: "How can the microcomputer system be used effectively in the construction field office or area office?" There are no easy answers because of the unique nature of the work in the field offices and personal preferences of office personnel. However, you know your job better than anyone else. You can determine, without any special computer knowledge, how to use a microcomputer effectively in your office, by focusing on the functional requirements. Only a logical and methodical approach, and a thorough understanding of the interrelationships among functions in your office is required.

Construction Field Office Functions

Construction field office functions are characterized by a great diversity of tasks. These tasks are demanding, complex, interdependent, and in most cases indispensable. However, at an abstract level, many of these tasks have a common underlying process. This process consists of the acquisition and processing of information (which includes using the information for management decision making), and the dissemination of some of the information. Construction managers should recognize that information is an important resource and it should be managed as such.

To realize the full potential of microcomputer support, it is important to look closely at this process of information handling. Many of the functions use the same input data or require aggregations of information processed in previous tasks. Many benefits of automation are based on the exploitation of this principle.

This fact explains the previous emphasis on the integration of software packages. Compared to manual procedures, computers can save cost in the proper applications. Further costs can be saved by realizing that data is expensive to input, compared to manipulating it once it is in the system. There is an economy of scale in the automation process; the more applications that can use the same data--the more economical it becomes to use the system.

Most field office computer systems will be justified on the basis of reducing the burden of paperwork, because paperwork can be anticipated and quantified. However, significant benefits can be expected from sources more difficult to predetermine. It is difficult to quantify the benefits associated with a computerized PMS. It is also difficult to quantify the benefits of more efficient methods of keeping and searching for records. Successful resolution of an inflated contractor claim as a result of better records handling can easily pay for the system.

Office Management and Project Administration

Most of the measurable benefits in these applications will come from three factors: (1) the ability of the computer to process information more efficiently by using common elements of information in your DBMS for different functions, (2) the improved ability to disseminate the information either by word processing or by transmitting it directly to another computer, for example, at the district, (3) improved management decisions based on more accurate and timely information.

Every day, in the course of doing their jobs, Corps personnel make many decisions that directly affect the success or failure of their organizational element's mission. For these decisions to be correct and timely, the information on which they are based must be complete, accurate, and available when it is needed. Table 1 is a list of construction office applications that have been identified by field office personnel. Of course the list is not complete, since additional applications are being identified as more microcomputer systems are placed in service. But you can use Table 1 as a starting point in determining how a microcomputer system can be used in your office.

ER 415-1-12 paragraph 5, 'Policy' states, "Microcomputer technology will be applied to the maximum practicable and justifiable extent to improve the performance of the Corps construction and project operations missions." This is Corps policy to be implemented by the divisions, districts, and field offices. The timetable for that implementation varies from district to district, with someone in every phase of the cycle at this time. In fact, some are in their second iteration of the cycle, as they have been using their present systems for some time now and are planning upgrading or replacement.

So that others may benefit from the experiences and initiatives of those further ahead in the cycle, USA-CERL is serving as a clearing house for Corps-developed applications programs. Programs for several of the applications listed in Table 1 have been developed and placed in the Corps' Applications Library. Descriptions of these programs, the proprietary software you will need to run them, and information on how they may be obtained is shown in the Construction Micro Notes newsletter. The Applications Library can also be accessed electronically on both the USA-CERL HARRIS 500 and the MICROS Knowledge Base.[5] The HARRIS 500 can be accessed by calling FTS 958-7250 or COMM 217/373-7250. The destination to be specified is "cmug" and the signon to be used is 333CMUG CMUG. For additional information on accessing the

[5]F. Mabry, W. Hohensee, and G. Norris, The Microcomputer Knowledge Base: Introduction and User Instructions, Technical Report P-155/A137694 (USA-CERL, January 1984).

Table 1

Construction Office Applications

Project Management

- Network Analysis System
- Construction Progress Schedule
- Progress Payments
- Payment Estimates
- QA Inspection Scheduling
- Change Order Analysis
- Claims Analysis
- Potential Delay Factors
- Resource Management/Allocation
- Contingency Funds Management
- Procurement Tracking
- Government Furnished Property Data
- Physical Data
- Environmental Data
- Quality Control Information
- Actual Progress

Contract Administration

- Modifications and Claims Status
- Submittal Registers
- General Contract Information
- Personnel Register
- Safety Data
- Payrolls
- Cost Estimating
- Correspondence/RFI Tracking
- Engineering Calculations
- Subcontractors

Field Office Management

- S&I Costs
- Office Budgets
- Workload Management
- Vehicle Operation
- Personnel Data
- Training Plans
- Property Accountability
- Meeting Calendars
- Leave Schedules
- Recurring Correspondence
- Electronic Mail
- Local Information
- Technical Library
- Regulations and Policy Library
- Time and Attendance Data
- Organization Charts
- Travel Data
- Tickler File
- Small Purchases Data
- Visitor Schedule
- Quality Assurance Data

MICROS Knowledge Base contact John Deponai, USA-CERL-FS, at FTS 958-7271 or COMM 217/373-7271.

There are about 40 programs in the Applications Library at this time (some are variations of the same application). As more microcomputer systems are placed in field offices, it is anticipated that more applications programs will be developed in those offices. It is likely that the future will see Corps-developed programs in the Applications Library for most field applications, and with some of the more universally used ones having several customized versions.

Project Monitoring

The Critical Path Method (CPM) computerized Network Analysis System (NAS) has been around for a long time, and since its introduction it has been accepted as one of the best systems for scheduling and monitoring construction programs. Unfortunately, early Corps experience with NAS scheduling was frequently disappointing and frustrating. Recent surveys still indicate that Corps field offices do not use computerized NAS to its fullest potential. There must be a reason for the Corps' reluctance to specify CPM scheduling on more projects.

Many Corps resident engineers will remember that after the computerized CPM was first introduced, it was only available on large computers at some distant computer service center. Input was entered by cards which included a time-consuming error correction cycle. Output was available only in the form of a lengthy printout. Updating was typically done monthly with the revised schedule reaching the construction site some 4 to 6 weeks later. Under these conditions the CPM was not only too unwieldy to comprehend, but also invariably outdated, if not incorrect. Often, only the contractor had access to the computer. It is therefore not surprising that CPM didn't win unanimous acceptance in the project environment. In the manner it was available, the CPM could not be used properly to control or monitor projects.

The availability of microcomputers which can provide inexpensive, onsite, easy-to-use Project Management Systems (PMS) makes it necessary to reexamine the position on CPM scheduling. CPM is a good management tool; the Corps' inability to use it successfully in the past was due to a lack of the computer capability necessary to use it properly. Today it is possible to use CPM effectively to analyze the construction schedule and monitor project progress.

Why this is possible may be less than obvious. The main reason is that microcomputers make it possible to have up-to-date scheduling, cost, and resource information available at all times. The capability to ask "what if" questions under these conditions makes a totally different mode of management possible--a proactive management mode as opposed to reactive. The microcomputer makes it possible to anticipate problems and initiate corrective action before the problems occur. This keeps more options open and allows more time for analysis and decision making. The ability to ask "what if" questions can greatly improve the ability to determine the impact of a proposed modification.

The real power of the modern computerized PMS lies in selection/reporting ability. This ability relieves the engineer of many paperwork chores.

Instead of getting reams of paper, you can ask for a report, for example, of all electrical activities that are behind schedule and (hopefully) get no more than a line or two of output.

Another example of chore saving is the ability of the PMS to automatically produce payment estimates based on your input of percent complete for individual activities. From the same input, a good PMS can produce cash-flow curves, project time or cost overrun projections, and a percent complete report. By using these reports, undesirable trends can be detected before they become problems. With help from the DBMS it can transfer the percent complete for the job to a summarizing status report for all jobs.

Implementation Considerations

Efforts to implement a microcomputer system in the office involve obtaining support for the system among office personnel and integrating the new system with your day-to-day operations. Two main factors influence how well personnel accept new computer systems: (1) The familiarity of the user with the system and (2) the system's potential to reduce activities the user perceives as time consuming and nonproductive.

The following general strategies should be used to get people to accept a microcomputer system:

1. Involve users and get their opinions early in the process of selecting and developing a new automated system.

2. Make the users aware that the system will reduce their less productive activities.

3. Provide adequate training for users.

4. Introduce the system with easy applications.

5. Avoid or delay personnel shifts that might appear to reduce personnel support.

6. Do not demand immediate acceptance of the system by all employees.

It will be necessary to plan how the system will be integrated with your existing operations. The following suggestions are offered in this regard:

1. Consider how long the present manual system will be used in parallel with the automated system.

2. Decide which personnel will be trained and which personnel will be using the system.

3. Assign a person to be responsible for the physical computer equipment and supplies. This individual would ensure supplies are ordered and would contact the maintenance service for repairs. Microcomputers do <u>not</u> require the full-time attendance of an operator.

4. Assign someone who is computer-knowledgeable or at least eager to learn to administer the system and develop the data base. In selecting an individual keep in mind the effort necessary to initiate the DBMS as discussed earlier.

Standardization

In previous sections, the ability to communicate data between computers was a recurring theme. Preliminary findings of a report on Corps construction activities reinforced the need for data communication in its recommendations.[6] According to the report, automated systems should be developed which can collect and disseminate information on topics such as quality assurance, lessons learned, and contractor performance. Current trends such as office automation, teleconferencing, and voice recognition all suggest that computer communication is becoming very important. Computer communication requires compatibility between different system components in one office, as well as between systems in different offices.

The matters of compatibility and communications are addressed in ER 415-1-12, including the recommended minimum standards for microcomputer hardware, operating systems, and software. Complying with the standards will not place a hardship on those selecting components; in fact, the knowledgeable buyer would automatically select items that are in compliance. The purpose of the ER is to establish a Corps-wide strategy for the implementation of microcomputer systems in construction field offices, and to provide certain basic information to those involved in selecting components and systems--it should facilitate the implementation of microcomputer systems with the desired capabilities.

Functional Analysis

With the information presented so far, you are now ready to proceed with the first and most important step toward computerization--the functional analysis. In the functional analysis, the field manager will identify those tasks in the office which can be easily carried out more efficiently by using a microcomputer. Some readers may decide not to do a comprehensive functional analysis, but instead will target a few promising functions for automation and experiment with the system. It is important in such a case to ensure the expandability of the system.

An important point to consider during the functional analysis is the degree of teamwork possible in planning your automation. Personnel in the office will more readily identify with and support the automation effort if they are consulted and encouraged to contribute in the early planning phases. More important, the quality of the functional analysis will be improved by their contributions. The functional analysis consists of three phases: identification, quantification, and justification.

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[6] U.S. Army Corps of Engineers, Draft Report of Blue Ribbon Panel on Management of Construction Quality in the U.S. Army Corps of Engineers (Water Resources Support Center, December 1982).

Identification

The obvious first step is to identify specific tasks and functions that would benefit from automation. Two approaches are presented here--the traditional and the zero-based. The traditional approach attempts to identify office functions for automation which currently exist. The second approach identifies the available inputs to the information processing activities in the office and the required outputs. Functions, which may not parallel existing functions, are then developed to achieve the required results. Operationally, the traditional approach tends to perpetuate existing functions in an automated fashion. The zero-based approach makes no assumptions about how tasks are currently done. It examines the fundamental objectives for the office and then determines what computer applications could be used to ensure that the objectives are achieved.

The traditional approach achieves the largest immediate savings in human effort, while the zero-base approach will aim at greater overall effectiveness. We suggest you follow both approaches in your functional analysis for comparative purposes. Functions identified for possible automation should, of course, be feasible within present microcomputer technology.

Traditional Approach. This approach is based on your identification of the functions that are now performed by your office and the tasks that are most time-consuming. The steps in this approach are listed below:

1. Identify all the major functions currently performed in your office. Table 1 in this chapter provides a number of functions for your consideration.

2. Assess or estimate the amount of time expended on each function and use this information to prioritize each function. In estimating the time expenditure, be careful not to omit secondary expenditures. For example, in assessing your manual filing system, include time spent in searching files for requested information or letters.

3. Try to consolidate functions when possible. Note that some of the low priority functions may be automated as a byproduct of a high priority function.

Zero-Base Approach. This approach requires that you try not to identify how the job is being done currently, but how it could be done with computer support. In a zero-based assessment you are considering a new way of treating information and you should expect to operate differently. The suggestions below will help you use the zero-based approach:

1. Remove yourself from the day-to-day chores, stand back and try to identify those factors which determine the difference between success and failure of the office. These factors are called critical success factors (CSF). Underlying the CSF are of course the objectives and the mission of your office. The most obvious examples of CSF for construction field offices are to ensure that projects are completed on schedule, within the budget, and according to the specified quality.

2. Trace back from each CSF the path of information elements that contribute to its success or failure. The information elements should be identified for each contributing task. From the resulting information flow network, you will be able to identify those functions which are most critical to the success of your job.

3. While recognizing certain forms and reports are required by higher authorities, try now to consolidate the tasks in the identified functions to achieve the necessary processing of information with a minimum of human intervention. This may eliminate some of your current practices and create new ones. For example, if completing a monthly payment authorization (from observed activity completion status as input) is a necessary task, the function of calculating the payment may be delegated to the computer. If you feel that human intervention or judgment is required in a task by all means let that be. The intention is to do a better job, not to replace people. Computerized management systems should be designed to incorporate the input of human judgmen at appropriate points in the processing of information.

4. Prioritize the functions you intend to automate. With the functions now identified, you may want to rearrange your prioritized list of functions to be automated using other criteria such as required accuracy, ease of implementation, low workload, lack of interest, or the cost and risk to implement a specific function.

Quantification

In this phase the functions under consideration for automation should be quantified as completely as possible. For example, estimate the number of letters you write for each project or the number of modifications and submittals required for each project. Give thought to the input and output of each function and try to define the standard forms and printouts you would like to implement.

The purpose of this exercise is to determine which of the functions listed for automation in the identification stage can in fact be automated, how it will work, and what the important attributes are. This also requires you to identify which software packages will be required to accomplish the desired automation. Appendix C lists a number of software packages you may want to consider. A thorough functional analysis will be of great value in getting your procurement request approved.

Justification

The objective of this phase is to estimate the benefits provided by the use of a microcomputer system in your office, and to prepare a list indicating the benefits associated with each function. The life-cycle benefits anticipated for each function will be compared to the life-cycle costs to determine that all functions to be automated are economically justified, and to assist you in the selection of a system properly sized for your operation. (System cost estimating and cost/benefit analysis are addressed in Chapter 5.)

Microcomputer system justification requires estimation of costs and benefits sufficient to identify a benefit/cost ratio of at least one over a life expectancy of not more than 4 years. Benefits may accrue from anticipated

project cost avoidance (i.e., better claim analysis, etc.) and cost/time savings. Benefits also include an improved capability to manage functions at field offices, the ability to develop and share common software applications between users, and the establishment of a baseline capability from which future automated support for field offices can emerge. Intangible benefits, such as better quality, in-depth investigation of "what ifs," etc., may be recognized but should not constitute the majority of benefits.

ER 415-1-12 prescribes priorities for various functional applications of microcomputer systems in construction field offices. For justification purposes the following are listed in order of priority:

1. Project Management

2. Contract Administration

3. Telecommunications

4. Field Office Management.

The use of microcomputers in field offices can improve the performance of the Corps' construction mission, and in the vast majority of cases is cost-effective. Most offices will easily justify the implementation of all four of the above applications in the basic system. The applications software recommended by the ER for any field office should as a minimum include a network analysis system, an electronic spreadsheet, a database management system, and a word processing system.

5 SELECTION PROCEDURE

Using information from the functional analysis discussed in Chapter 4, this chapter will assist you in selecting the specific system characteristics to satisfy your office automation needs. Two alternative procedures will be presented and discussed: competitive bid procurement and sole source procurement.

Introduction

Three different processes can be followed for procurement of a microcomputer system. The recommended procedure is procurement of a system through the Federal supply schedule. Since the GSA Multiple Award Service contract has been pre-competed, this procedure is a competitive bid procurement; however, the procurement time is greatly reduced because a performance specification does not need to be written and advertisement for bids is not required. Procurement of microcomputer systems from the Federal supply schedule also allows the purchaser to specify equipment by vendor and model. Over the past year the GSA has awarded several contracts to vendors for the supply of end user computers and peripherals. Information about these vendors is presented in Appendix F.

If the selected microcomputer is not included on the Federal supply schedule, the following procurement alternatives exist. For those who do not have a thorough knowledge of microcomputer technology and specifications for the myriad of products on the market, the competitive bid procurement using a performance specification is best. It provides access to the ingenuity and expertise of system integrators and places the responsibility for producing a successfully integrated and usable system upon the contractor. You remain within the area of your expertise in defining your functional requirements and performance standards. A sample performance specification is presented in Appendix G. The sample specification has not been used in an actual procurement, and it is offered as guidance only for the issues to be considered. While sole source procurement is not recommended, it is a possible alternative for the procurement of a microcomputer system. However, justification of an initial, self-contained microcomputer system may be difficult within the framework of existing Army procurement regulations.

Regardless of the procurement strategy selected, you will need to follow several steps which are discussed in the rest of this chapter. The most important of these steps relate to determination of:

1. Mass data storage capacity and technology
2. Number of work stations
3. System configuration
4. Required peripherals

5. Cost-Benefit analysis

6. System cost estimate.

Mass Data Storage Requirements

As described in Chapter 3, mass storage devices use either floppy disks or hard disks. The construction field office microcomputer system will need both. Floppy disk drives are necessary to facilitate the input of software programs and for maintaining backups. Hard disk drives are necessary for data storage because of their greater capacity and faster transfer rate. You will need to determine how much storage space is needed, and how you wish to distribute this between floppy and hard disk media.

ER 415-1-12 recommends a 10-Mb hard disk and a 320- to 400-Kb (5 1/4-in.) floppy disk as the minimum for construction field offices. Hard disks should be provided on each work station even if several work stations are networked together with an LAN and a centrally shared hard disk. This will avoid system degradation caused by disk contention.

Hard disk capacities range upward from 5 Mb in increments of about 5 Mb, depending on the manufacturer. It is cheaper to buy one 10 Mb than two 5 Mb drives, and cheaper to buy one 20 Mb than two 10 Mbs. Experience has shown that the uses to which a microcomputer system is placed almost always exceed those anticipated during planning. The wise planner will specify storage requirements that allow room for expansion. For example, if your storage requirements estimate indicates you need 13 Mb, the 20-Mb disk drive would be the appropriate choice. Selecting a 10-Mb and a 5-Mb combination may be somewhat cheaper at first, but since you would have little room for expansion, you may need to purchase another hard disk drive in the near future. This piecemeal building of storage capacity is far more costly than getting enough the first time.

Do not underestimate your mass data storage requirements. Leave room for expansion.

Estimating Minimum Storage Requirements

Theoretically, the objective of estimating storage requirements is to determine the total number of alphanumeric characters that will reside on online storage at the planned maximum storage demand. One alphanumeric character, in the ASCII representation, requires one byte of storage. Using this conversion factor, it is possible to estimate the required storage in bytes or MBytes from the number of characters to be stored. However, due to overhead in a DBMS, the actual conversion factor is between 1.2 and 1.8 bytes per character. To alleviate this uncertainty, USA-CERL experimentally determined an average number of bytes per record. (In the following discussion a "record" refers to a storage unit of information such as one letter or information regarding one submittal.) This average number is accurate enough to be used in estimating your storage needs. The estimate is obtained using the steps identified below. Sample calculations are provided in Worksheet 1 in Figure 3. Blank worksheets are provided in Appendix D.

Worksheet 1

Needs Assessment

Activity Category (Project Information)	Number of Projects		Average Per Project		Product
1. Contractor/ subcontractor info.	31	x	10	=	310
2. Correspondence (letters & memos)	31	x	160	=	4960
3. Pending change orders	31	x	20	=	620
4. Safety reports	31	x	15	=	465
5. Inspection schedules	31	x	2	=	62
6. Shop drawings	31	x	320	=	9920
7. _____	____	x	____	=	____
8. _____	____	x	____	=	____
9. _____	____	x	____	=	____
			TOTAL		16337

TOTAL Total in nearest thousand 16 (A)

Critical Path Method

Total number of activities for all projects to the nearest thousand 11 (B)

Estimate of Required Storage

$$1.2 \left(\frac{16}{\text{(A above)}} \times 0.350 + \frac{11}{\text{(B above)}} \times 0.450 + 0.950 \right) = 13.8 \text{ (C)}$$

Figure 3. Example Worksheet 1.

1. Use Worksheet 1 to list all the functions that you have selected to be stored on-line. The six functions listed in the sample worksheet were those identified as requiring the most storage space of those functions typically considered for automation.

2. A maximum number of on-line records must be estimated for each function. This is done by multiplying the number of projects managed by the average number of records per project. The following projections are required to make this estimate:

a. The number of projects used must be the largest number of concurrent projects you anticipate at any time during the next 3 years (or the life cycle of the system).

b. The average number of records will depend on the phasing of individual projects for which two extremes exist. If you intend to keep all records pertaining to a specific project on-line until closeout and all projects are completed simultaneously, then the average number of records will be the average of the maximum number of records for each project. On the other hand, if the projects are evenly distributed, the average will be somewhat above half this maximum number.

3. Add all the project x record products which is then expressed in thousands to arrive at result A.

4. Consider all the projects (used in 2a above) that you plan to actively monitor on your systems. Estimate the total number of activities for all projects. This number expressed in thousands constitutes result B.

5. To estimate the minimum storage requirements, the following formula should be used:

$$\text{Unformatted storage [Mbyte]} = 1.2\ (0.35A + 0.45B + 0.95) \qquad \text{[Eq 1]}$$

Where:

1.2 = Conversion factor from formatted to unformatted storage
0.35 = average number of Mbytes per thousand records
0.45 = average number of Mbytes required per thousand CPM activities
0.95 = storage required for all on-line programs in Mbytes.
A = total number of records in thousands
B = total number of CPM activities in thousands

Number of Work Stations

The total number of work stations needed, where a work station includes a CPU, monitor, keyboard, floppy disk drive, hard disk drive, and software, is determined by user contact time. User contact time depends largely on how much information must be put into the system, how often it is updated or changed, and how often the data is viewed or reported. Another consideration is the efficiency and convenience of having a free work station available when it is needed. These factors, which were based on an estimate of average

requirements, are built into the worksheet for determining work station requirements (Figure 4).

The following procedure should be used with Figure 4 to determine the work station requirements of your office:

1. Determine how the user contact time will be distributed among office staff. The simplest procedure is to list each employee and the average amount of time, to the nearest hour, you anticipate each individual will require at the work station per day.

2. Add together all users who will be working at the system the same amount of time per day; e.g., one user requiring 6 hours, three users requiring 1 hour, etc.

3. Place the calculated value for each time requirement in the appropriate row in the "Number of Users" column.

4. Calculate the "Product" for each row by multiplying the "Factor" times the "Number of Users."

5. Calculate the total of all products and total number of users.

6. If the product total is not an integer, round the number to the next largest integer. This value will be the minimum number of work stations required by your field office. Other considerations such as the physical arrangement of the office may create the need for more work stations.

System Configuration

With the storage requirements and the estimate of the number of work stations required, you are now able to use Figure 5 to select the minimum appropriate system configuration which will meet your office's needs. This is done by identifying the column in Figure 5 with the total number of work stations necessary for your office. Having done this, you need only read the numbers in the rows of that column corresponding to dot matrix printers, letter quality printers, modems and other peripherals. For example, if a minimum of four work stations are required, the system will include the following: four work stations, two dot matrix printers, one letter quality printer, one modem, and any other peripherals necessary. If your office requires a number of work stations it is important to be able to share information between them, therefore an LAN becomes a necessary peripheral device. Chapter 2 discusses the function and advantages of using an LAN to provide shared information capabilities.

If the number of work stations required is larger than that shown in Figure 5, i.e., more than 10 work stations, simply continue the cycles shown for adding system components. For example if 11 work stations are required, six dot matrix printers, and three letter quality printers would be required.

Work Station Time (Hrs/Day)	Factor	x	Number of Users	=	Product
8	1.00	x		=	0.00
7	0.88	x		=	0.00
6	0.75	x	1	=	0.75
5	0.63	x		=	0.00
4	0.52	x	1	=	0.52
3	0.41	x	2	=	0.82
2	0.31	x	1	=	0.31
1	0.25	x	3	=	0.75
	Totals		8		3.15

Number of Work Stations Required*: 4

*(Round 'Product Total' upward to next whole number)

Figure 4. Work station requirements.

	Work Stations									
Items	1	2	3	4	5	6	7	8	9	10
Work Station*	1	2	3	4	5	6	7	8	9	10
Dot Matrix Printer	1	1	2	2	3	3	4	4	5	5
Letter Quality Printer	1	1	1	1	1	2	2	2	2	2
Modem**	1	1	1	1	1	1	1	1	1	1
Other***										

*A workstation consists of a CPU, monitor, keyboard, floppy disk, hard disk, and software.

**Additional modems should be added as needed.

***Items such as plotters, graphics and LAN hardware and software, centrally shared hard disk, etc. would be obtained with the initial system and/or as needed thereafter.

Figure 5. Microcomputer system configuration.

In addition, it is necessary to determine if the selected system configuration will meet your minimum storage requirements. To check this, simply multiply the number of work stations selected by 10. If the product is less than the storage requirement calculated in Worksheet 1, additional storage should be added to your system. To add more storage, either the hard disk drive on the busiest user station(s) should be increased by increments of 10 Mb until sufficient storage has been provided, or a centrally shared hard disk should be added via an LAN and disk server.

For additional assistance in sizing and selecting your system, contact your ADP coordinator or USA-CERL. USA-CERL can provide up to 2 man-days of assistance free of charge to Corps and other Army organizations under the USA-CERL Small Problems Program. The objective of the Small Problems Program is to apply USA-CERL's technical capability to a user's problem while it is still small and amenable to a quick solution. More information concerning this program may be obtained from the Public Affairs Office at USA-CERL: FTS 958-7216, COMM (217) 373-7216.

Peripherals

Since the selected system is a recommended minimum configuration it is essential to carefully consider the number of peripherals to ensure procurement of a system which will satisfy the unique needs of your office. The selected peripherals must be designed for compatibility with other system components. They do not have to be products of the same manufacturer, but maintenance may be simpler if they are.

Just as you analyzed your office functions and operations to determine the number of work stations required and mass storage needs, you need to analyze office procedures to determine what kind of printers you need, and how many. There must be some correlation between the number of work stations and the number of peripherals needed to support the operation. The kinds of applications performed and the physical location of work stations also affect the kinds and numbers of peripherals needed. Each of these factors has been taken into account in the configuration table shown in Figure 5.

Normally, one letter quality printer will support two word processing work stations; one high-speed printer will support two NAS work stations; and one high-speed printer will be necessary to support DBMS and spread sheet applications. At least one modem is required, and a plotter or printer with multicolor capability will be needed for some graphics applications. Make sure the microcomputer(s) you select can drive the peripherals you need, and make sure you do not underestimate your peripheral needs. System users should not be delayed waiting to access a printer. If you anticipate special needs or intend to dedicate a work station to a specific peripheral intensive activity, some adjustment of the recommended configuration may be necessary.

More peripherals can probably be added to the system later, but it is better to have a complete, usable, and efficient system initially.

Once you've listed the components to be included in the system, turn to Appendix A for specific information concerning the minimum acceptable standards for each piece of hardware or software needed for your system. This information should be part of the performance specification if competitive bid

procurement is being used for systems not on the Federal supply schedule. For a list of vendors whose products meet these minimum standards, see Appendix B for hardware and Appendix C for software.

Cost/Benefit Analysis

For a cost/benefit analysis, the total life-cycle cost should be estimated. In addition to the initial purchase price, other cost items such as training, maintenance, and supplies should be considered. The expected life-cycle costs should be compared with the expected life-cycle benefits. Identifying expected benefits was discussed in Chapter 4.

Microcomputer system justification requires estimation of costs and benefits sufficient to identify a cost/benefit ratio of at least 1 over the expected life of the system. Due to the rapidly changing technology, life expectancy should not exceed 4 years.

The benefits available from the use of microcomputer systems in field offices are great and well-recognized, while the costs are relatively low and getting lower, so practically no one should have difficulty with the cost/benefit analysis or justification.

System Cost Estimate

The remaining procedure outlined here can be used two ways. First, for procurement of microcomputer systems on the Federal supply schedule, the procedure can be used to select a specific system from the models listed in Appendix B. Second, where competitive procurement using a performance specification is necessary, an estimate of the cost to the Government can be prepared by comparing the prices of some of the microcomputer systems listed in Appendix B.

To use the estimating procedure, first determine the system configuration based on the steps outlined earlier in this chapter. Next, select a number of candidate systems and peripherals from the list in Appendix B which meet your system configuration needs. Fill out a copy of worksheet 2 for each system to record the necessary information. Before proceeding, read through the following instructions on how to fill out worksheet 2.

Filling Out Worksheet 2

1. Make a copy of the blank worksheet 2 in Appendix D, for each system being considered.

2. Transfer the information indicated below about each system from Appendix B to worksheet 2. Figures 6 and 7 are examples of a completed worksheet 2 for two fictitious vendors.

   a. The hardware vendor's name.

   b. The system name or model (if any). Be sure to note the quantity if more than one is required.

Worksheet 2

System Evaluation

A. Hardware vendor's name: XYZ COMPUTERS, INC.

System name: Z-PLUS

Basic hardware price: $4740 ea. Quantity: 2

B. Optional software:

Qty	Vendor and software name	Price
1	Network Analysis System	$1400
2	Word Processor	700
2	DBMS	900
2	Spreadsheet	800
1	Communications	250
2	Graphics	500
	SOFTWARE SUBTOTAL	4550
	BASIC HARDWARE SUBTOTAL	9480
	SYSTEM PURCHASE PRICE	19710

C. Optional hardware:

Qty	Vendor and product name	Prices
2	10 Mb Hard Disk	INCL.
2	Graphics Board	INCL.
1	Dot Matrix Printer	1500
1	Letter Quality Printer	2700
1	Modem Board	600
2	Additional 256Kb RAM	880
	HARDWARE SUBTOTAL	5680

D. Comments Has a high resolution monitor and a streaming tape backup unit included in price. Available locally, with local training available on both hardware & software.

E. Scoring matrix

		Cost	Score (1-10)	Weight	Points
1.	System Purchase	19,710	9	30	270
2.	Maintenance	2850	8	20	160
3.	Training	500	9	20	180
4.	Performance	—	8	30	240

TOTAL COST = $23060 TOTAL POINTS = 850

Figure 6. Example Worksheet 2.

System Evaluation

A. Hardware vendor's name: ABC Micro, Inc.

System name: ABC-TX

Basic hardware price: $4550 ea. Quantity: 2

B. Optional software: C. Optional hardware:

Qty	Vendor and software name	Price	Qty	Vendor and product name	Prices
1	Network Analysis Software	$1400	2	10 Mb Hard Disk	INCL.
2	Word Processor	700	2	Graphics Board	$900
2	DBMS	900	1	Dot Matrix Printer	1500
2	Spreadsheet	800	1	Letter Quality Printer	2700
1	Communications	250	1	Modem Board	600
2	Graphics	500	2	Additional 256Kb RAM	880
			2	High Resolution Monitors	1400
	SOFTWARE SUBTOTAL	4550		HARDWARE SUBTOTAL	7980
	BASIC HARDWARE SUBTOTAL	9100			
	SYSTEM PURCHASE PRICE	21630			

D. Comments Available locally, however, no local training is offered. Necessary to purchase higher resolution monitor than that which is included with the system.

E. Scoring matrix

		Cost	Score (1-10)	Weight	Points
1.	System Purchase	21630	7	30	210
2.	Maintenance	3010	8	20	160
3.	Training	1700	7	20	140
4.	Performance	—	7	30	210

TOTAL COST = $26,340 TOTAL POINTS = 720

Figure 7. Sample completed Worksheet 2.

c. The basic hardware price. (Note: This excludes the price of peripherals such as printers, and modems.)

This completes section A of the worksheet.

3. Review your functional analysis (see Chapter 4) and decide which software packages are needed for your office. Now select the actual software packages you intend to acquire from those listed in Appendix C. List these packages with pricing information in section B of worksheet 2.

4. Decide what peripherals will be needed for your office (modems, number and type of printers, etc.). Select the peripherals and the quantity of each you intend to acquire from those listed in Appendix B, and transfer the information to section C of worksheet 2.

5. At this point, you can calculate the direct purchase price for the entire system by adding the totals for sections A, B, and C. Transfer this information to E.1 in the scoring matrix.

Before going further with the evaluations, you should now try to determine details relating to training and maintenance for each of the candidate systems. Refer to Chapter 2 for a discussion of maintenance and Chapter 3 for a discussion of training.

6. Contact the vendor as well as independent service organizations for details on the maintenance of the system. Try to get the following information:

a. The types of maintenance available, such as onsite maintenance, modular-component field replacement, or return of entire system to vendor.

b. The cost of maintenance--determine whether it is a fixed rate for a yearly contract, or whether the maintenance is based on the number of calls and if it includes travel costs.

c. How long it will take for the vendor to respond to a maintenance request at your specific site, and the maximum repair or replacement time.

Keep the facts on file and note the most important features in section D of worksheet 2. Transfer the estimated life-cycle maintenance cost to E.2 in the scoring matrix.

7. Contact each vendor organization and ask for information on training and documentation. Documentation and user's manuals should be aimed at professionals without formal training in computer science. The documentation should be available for each software package. Attempt to obtain information regarding training courses and estimate the initial and recurring training cost for the life cycle of the system. The life-cycle training cost should include any traveling and incidental costs required for training activities. Record the most important features of the available training in section D of worksheet 2, and enter the total life-cycle training cost to E.3.

8. Include any additional costs for the system which were not specifically addressed by this procedure. Examples of additional costs include the transportation of equipment to remote locations or custom software integration. You can now complete the estimate by adding the cost estimates in the total cost column in the scoring matrix.

If a microcomputer system which is not on the Federal supply schedule is being procured through competitive bidding, the following discussion of system selection does not apply. Instead, the information put together up to this point should be used to write a performance specification for the system your office requires. A sample performance specification is presented in Appendix G to assist you in this process. To ensure procurement of a system to suit your needs, the sample performance specification should be revised to include the system specifications you have identified.

System Selection

Once the costs of the various systems have been determined, you are now ready to select a system. The right-hand side of the scoring matrix in worksheet 2 is designed to help you make your selection. The following steps explain how to complete the right-hand side of the scoring matrix for each worksheet.

1. The first step is to establish relevant weighting factors for each of the listed features. You may want to include more features, or further define some features. For example, performance may be broken down into hardware performance and software performance. The weighting scheme used will vary according to your preference, but it is suggested that weights be used similar to those in Figures 6 and 7.

2. Compare the total system purchase cost for each system under consideration, and rate it on a scale from 1 to 10 with 10 being the most desirable. To explain the rating of the example systems in Figures 6 and 7, assume the Government estimate of the system purchase price is $21,000. An arbitrary linear function is then developed to set a bid equal to the Government estimate at a rating of 8, such as in Figure 7. The system in Figure 6 is lower than the Government estimate, and according to the developed function scores a 9. Multiply the rating score by the weight factor to arrive at the point entry.

3. Consider the total life-cycle maintenance cost, and your notes and comments regarding maintenance for each system. Rate the available maintenance schemes for each system on the 1 to 10 scale. Some factors to consider include the following:

a. What is the maximum time the system can be down before your operation is significantly inconvenienced?

b. How long can you be without the system before office functions are seriously disrupted?

c. If the vendor claims that its system has some form of self-diagnostic support, then you must decide if someone on your staff has enough

technical background to talk with the vendor about the system's maintenance in case of a system failure.

4. Consider and rate the cost and information about available training. The following factors should be included in the evaluation.

a. The venue of training--onsite or at the vendor. Remember to consider traveling and incidental costs.

b. Is the training consolidated with one vendor?

c. Try to evaluate the quality of the training and the available documentation.

5. Compare and rate the performance characteristics for each system using the recommendations made in the guide. If possible, inspect the system components and ask for a demonstration of each software package. Include in your consideration any special required performance features or factors such as expandability.

6. Add the points for each system. The system with the highest total score, according to this analysis, is the best system for your office. The procurement procedure for acquisition of the system is outlined in Chapter 6.

6 PROCUREMENT

Two things have happened since the first edition of this guide was published that have a significant impact on procurement strategies for microcomputer hardware and software for construction field offices. They are:

1. The GSA has negotiated a Multiple Award Schedule Contract (FSC Group 70, Part 1, Section C Schedule) with many vendors to supply microcomputer systems to the Government at a substantial discount.

2. ER 415-1-12 has been issued, strongly recommending the use of GSA Section C for the procurement of microcomputers whenever possible.

Purchasing hardware and software through GSA channels is competitive procurement which allows the buyer to specify products by proprietary name, model number, etc. Purchasing from the GSA schedule also reduces procurement cycle time (see Figure 8). The time otherwise required to prepare specifications, advertise for bids and evaluate them is saved, because these activities were previously accomplished by GSA.

The use of GSA vendors can reduce the time for actual procurement, but preceding that must come the identification of funding and obtaining procurement approval.

Funding

The following discussion of funding is reproduced from ER 415-1-12.

Microcomputer Purchase

a. The Plant Replacement and Improvement Program (PRIP) will generally be the primary funding source for microcomputer purchases. Purchase via PRIP requires close coordination with District and possibly higher level USACE Comptrollers. Monthly reimbursement of the PRIP revolving fund is required from project funds. Some exceptions to this general rule are as follows:

- Microcomputers which will be used exclusively for civil works projects may be purchased using project funds. The Civil-appropriated Construction General (96x3122) or Operations and Maintenance (96x3123) funding sources apply in this regard.

- Europe, Japan, and Far East will use their Carrier Fund.

Microcomputers for projects totally funded by other than DOD agencies (Saudi Arabia, Department of Energy, NASA, and others) may be purchased using project funds.

b. Other Procurement, Army (OPA) funds are a possible funds source when the microcomputer system(s) will be used solely on military projects. Yearly OPA funds requests for ADP equipment are normally prepared by the District ADP Coordinator. Note that OPA funds cannot be assured and long lead times may be experienced.

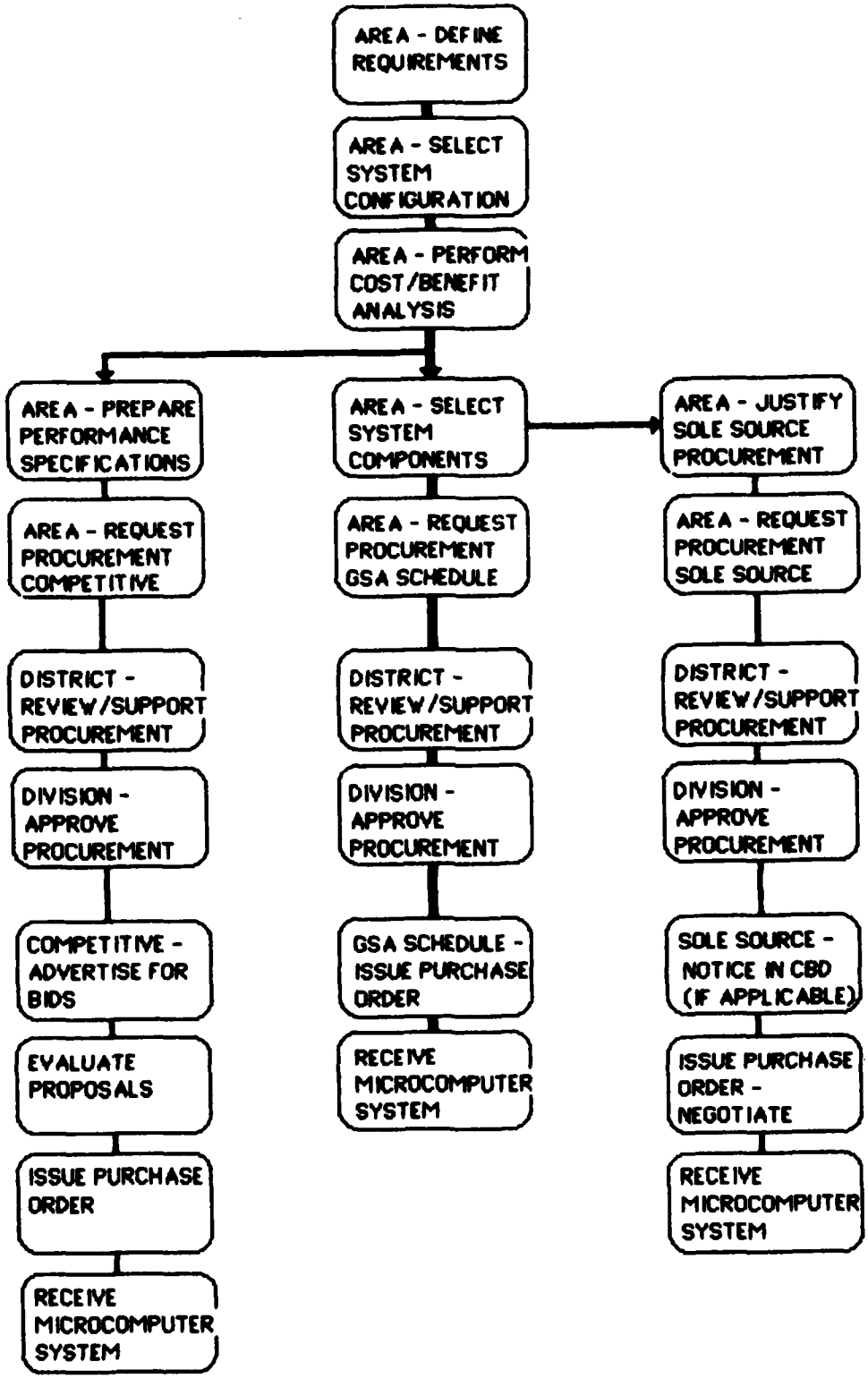


Figure 8. Procurement process for microcomputer systems.

c. Other sources are sometimes available on special occasions as initiated by Headquarters, Department of the Army (HQDA). An example is the Quick Return on Investment Program (QRIP) which is a special solicitation by HQDA. QRIP funding cannot be assured; however, field input for possible funding is encouraged where possible long lead times and delays will not adversely impact procurement.

Other Support Requirements

a. Maintenance. Maintenance of microcomputer hardware, after the warranty period, and software maintenance as required, will be funded by the S&A account or other applicable project operating funds.

b. Software and Peripheral Devices. QRIP, OPA, and S&A account, or other applicable project operating funds may be used to procure software and additional peripheral equipment. Standard peripheral devices should be included in the initial acquisition and will not be incrementally purchased to avoid using the PRIP revolving fund account.

Approval Process

Field offices should work closely with their District ADP Coordinator to obtain procurement approval. The Division Engineer has approval authority when:

a. ADP equipment is acquired through competitive procedures, does not exceed 10 computers, and does not cost over $70,000.

or:

b. ADP equipment is acquired noncompetitively, does not exceed 10 computers, and does not cost over $50,000.

Requests for approval must be supported by a cost/benefit analysis producing at least a 1/1 ratio over the expected life of the system. (Chapter 4 contains guidance on quantifying benefits, and Chapter 5 addresses estimating applicable costs.)

Procurement Process

The two main avenues of acquisition are:

a. Competitive

b. Sole source.

Competitive

Competitive procurement is preferred because it provides the Government the advantage of lower price due to marketplace competition. Competitive acquisition may be employed in two ways. First, analyze your needs, identify the appropriate system configuration, evaluate the various systems capable of

meeting your requirements, and select a system that produces the best cost/benefit ratio. Then:

1. If the products so identified are available through the GSA schedule, purchase the system from the GSA contractor, using the GSA prescribed procedures. (Appendix F contains more information about the GSA schedules and ordering and payment procedures.)

2. If the products so identified are not available through the GSA schedules, you need to prepare performance specifications, advertise for competitive bids, evaluate the proposals received, and issue a contract to the successful bidder. (Appendix G contains a sample microcomputer system performance specifications.)

Sole Source

Sole source procurement will normally only be approved for additions to existing systems where there are overriding compatibility considerations. Justification for sole source procurement, in accordance with the requirements of AR 18-1, requires the completion of an "Appendix I."[7] An example of an "Appendix I" and other pertinent documentation is in Appendix H of this guide. Note that this is only an example. The IBM PC and PC-XT are now on the GSA schedule and hence do not require sole source justification.

Procurement Cycle

Figure 8 depicts the steps in the procurement cycle for different procurement strategies. The procurement time will vary depending on organizations and the procurement procedure used, i.e., GSA, sole source, or competitive bid, so you should consult your ADP coordinator for a realistic estimate of procurement time. You planning should take into account that from the time you start to assess your requirements until the microcomputer system is delivered may be several months.

[7] AR 18-1, Army Automation Management (Headquarters, Department of the Army, 15 August 1980).

7 CONCLUSION

Significant benefits can be realized from using microcomputer systems in construction field offices. Microcomputers can improve management decisions and reduce construction costs.

Over the past year microcomputer technology has continued to progress at an almost phenomenal rate. Keeping on top of this technological explosion requires a major effort on the part of all interested parties. Corps construction field offices can benefit greatly from taking advantage of the new developments in both hardware and software. This revised guide has presented several new developments ranging from the arrival of 16-bit microcomputers and integrated software packages capable of exploiting the additional power of the 16-bit machines, to the emergence of widespread use of 10-Mbyte hard disks.

The information in this guide can help to develop an understanding and appreciation of the applicability of microcomputers. This guide can also help construction field office managers select and acquire microcomputer systems which are best suited to their needs both now and in the future.

APPENDIX A:

RECOMMENDED MICROCOMPUTER SYSTEM

This appendix summarizes the recommendations in ER 415-1-12 and the main text of this guide without restating the reasons for the recommendations. This summary describes a system containing most of the desirable features available in cost-effective microcomputer systems.

General Considerations

Compatibility

The system should be compatible with microcomputer systems in other field offices in the district and ideally with all microcomputers in the division. This compatibility will allow the training and applications software development costs to be shared by all district elements. The system should also be able to transmit data via telephone to other computers in the district and division.

Availability of Software

A large base of off-the-shelf software should be available for the microcomputer system selected. Software packages should be selected first; then the microcomputer system should be selected based on its ability to run the selected software. If sole-source procurement is used, it is essential to ascertain that the selected software performs properly on the desired microcomputer system.

Maintenance

Maintenance should be available for the system from a vendor or national service organization. The selected maintenance service should meet any necessary response time and repair time constraints.

Training

Before beginning the procurement process, sources should be identified for obtaining adequate training at a reasonable cost.

System Configuration

Since new uses for the computer are discovered as the users' expertise grows, the selected system configuration should allow for adequate expandability over the life of the system. If a network approach with multiple work stations is taken, the network should provide for the addition of work stations as well as peripherals. If the multi-user approach is taken, the system should be configured to ensure that performance is not degraded to an unacceptable level when additional user stations are added. Multi-user systems also should be capable of functioning as part of an LAN.

All components of the system should be fully compatible and well integrated to allow full utilization by the software. This integration should include adequate buffering between components to prevent character loss or overflow during communication.

Hardware

Central Processing Unit(s) (CPU)

A typical work station should use at least a 16-bit CPU, although a 16-bit CPU with an 8-bit CPU co-processor is acceptable. Work stations with a 32-bit CPU are also acceptable.

Main Memory

At least 512 Kbytes of direct memory access RAM should be provided for each work station.

Floppy Disk Data Storage

A minimum of one 5 1/4-in. 320- to 400-Kbyte floppy disk drive should be provided for each work station for backup and the exchange of data and programs with other offices. Additional floppy disk drives, 3 1/2-in., 5 1/4-in. or 8-in. are optional.

Hard Disk Data Storage

Each work station should be provided with a hard disk drive that provides a minimum storage capacity of 10 Mbtyes. A generous amount of hard disk storage should be provided at each work station to allow for future growth, because adding storage after the initial purchase is considerably more expensive.

Monitor and Keyboard

Each user station should consist of a monitor and a keyboard with the following characteristics. The monitor should display a minimum of 24 lines by 80 columns. The video should be amber or green display with a resolution of at least 640 x 200 dots per in. Additional features of the monitor include an addressable cursor, reverse video, highlighting, and use of the full ASCII character set. The keyboard should look and feel like the keyboard of a high quality typewriter, have programmable function keys and should be detachable.

Peripherals

Letter Quality Printer

A daisy-wheel printer should be included in the microcomputer system to print documents that require a high quality typewritten appearance. The printer should have a tractor feed for handling continuous fan-fold paper and be capable of handling individual sheets as well. The printer should be capable of printing at least 40 characters per second (cps) and include such

features as: superscript, subscript, underline, boldface, multiple spacing, variable fonts, and manually adjustable form lengths.

Dot-Matrix Printer

The dot matrix printer should be able to print in both a correspondence mode at a minimum of 80 cps for internal memos, and a draft mode at a minimum speed of 200 cps for long internal reports and NAS printouts. The printer should be capable of printing on paper up to 14 7/8 in. wide. Other features required of the dot-matrix printer are the ability to produce printer graphics and perform the functions described earlier for the letter quality printer.

Modem

The modem should be a direct connect modem or an internal modem board, compatible with the Bell 103/212A standard, and switchable to send and receive data at 300 or 1200 baud. The modem should also have auto-answer and auto-dial capabilities.

Software

Operating System

The operating system for each 16-bit CPU should, as a minimum, include MS-DOS or PC-DOS and CP/M-86. CP/M-80 for user stations with an 8-bit co-processor is optional. Concurrent PC-DOS or Concurrent CP/M operating systems should be used when multitasking capabilities are necessary. The UNIX operating system (or some version of it) should be used for user stations with a 32-bit CPU.

Software Packages

The software packages resident on any one work station should be determined based on the specific functions to be performed at that work station, i.e., it is not recommended that a network analysis system be resident on a work station which will be used solely for word processing. The required software packages for each field office include a network analysis system, a data base management system, an electronic spreadsheet package, a word processing package, and a communications software package.

APPENDIX B:

LISTING OF AVAILABLE HARDWARE

This appendix contains examples of microcomputers, monitors, keyboards, letter-quality printers, dot-matrix printers, modems, local area networks and power protection devices. The information is current as of September 1984--the time of printing. The microcomputers listed alphabetically by manufacturer in Table B1 represent a partial list of available microcomputers which meet the recommendations discussed in the text. Each microcomputer includes a 16-bit CPU, monitor, keyboard, at least one diskette drive, a 10-Mbyte hard disk drive and an operating system. Any changes to this configuration are specifically noted. The addresses of the manufacturers of the microcomputers listed in Table B1 are provided in Table B2. Peripheral devices are listed in Tables B3 through B9.

Samples of the peripherals listed in Tables B3 through B9 are provided for illustration, since not all of them will be compatible with every microcomputer in Table B1. It is recommended that you contact the vendor(s) of the selected system(s) for suggestions on compatible peripherals. The peripheral tables can be used to select components for estimating the cost of a complete system. All prices in Appendix B are suggested list prices for standard versions of the listed equipment unless stated otherwise. Discount prices are available on most items. The GSA price, if the item is on the Federal supply schedule, will in most instances be 15 to 30 percent off the list price. It is likely that users may select options that will alter the listed prices.

Table B1

Microcomputer Systems

Manufacturer: *AT&T*

System Model: Model 6300

CPU/Clock Speed: 8086-2 @ 8MHz

Min.-Max. Memory: 128 to 640 Kb

Ports:
- RS232 1
- Parallel 1

Expansion Slots: 7

Mass Data Storage:
- Max. Floppy Drives/Capacity (Kb) 2 @ 360 Kb
- Max. Hard Disk Drives/Capacity (Mb) 1 from 10 Mb to 50 Mb

Software

Operating System: MS-DOS, Concurrent CP/M, Concurrent PC-DOS

System Cost: $4985

Included Equipment:
- Hardware: CPU, 128 Kb; monitor, keyboard, one 360-Kb diskette drive, one 10-Mb hard disk.
- Software: None

Note: Optional hard disk up to 50 Mb and a streaming tape backup unit are available, as is a high resolution graphics video interface. Three slots are 16-bit compatible, and four slots are 8-bit compatible socket for a coprocessor. It has versatile keyboard and monitor configurations.

Manufacturer: *Columbia Data Products*

System Model: MPC 1600-4

CPU/Clock Speed: 8088 @ 4.77 MHz

Min.-Max. Memory: 128 Kb to 1 Mb

Ports:
- RS232 2
- Parallel 1

Expansion Slots: 8

Mass Data Storage:
- Max. Floppy Drives/Capacity (Kb) 2 @ 320 Kb
- Max. Hard Disk Drives/Capacity (Mb) 1 @ 12 Mb

Operating System: MS-DOS, CP/M-86

System Cost: $4545

Included Equipment:
- Hardware: CPU, 128 Kb; one 320-Kb diskette, one 12-Mb hard disk
- Software: MS-DOS, CP/M-86, Perfect Writer, Perfect Speller, Perfect Calc, Fast Graphs, Perfect Filer, GW Basic, Macro-Assembler

Note: Does not include monitor or keyboard.

Table B1 (Cont'd)

Manufacturer: *Compaq Computer Corporation*

System Model: Deskpro Model 3

CPU/Clock Speed: 8086 @ 8.0 MHz

Min.-Max. Memory: 128 to 640 Kb

Ports:
- RS232 1
- Parallel 1

Expansion Slots: 4

Mass Data Storage:
- Max. Floppy Drives/Capacity (Kb) 2 @ 360 Kb
- Max. Hard Disk Drives/Capacity (Mb) 2 @ 10 Mb

Operating System: MS-DOS, CP/M-86

System Cost: $4740

Included Equipment:
- Hardware: CPU, 256 Kb; monitor, keyboard, one 360-Kb diskette drive, one 10-Mb hard disk.
- Software: MS-DOS, BASIC

Note: Features high resolution display, graphics capabilities, optional 10-Mb streaming tape cartridge backup unit. Also includes asynchronous communications/clock board.

Manufacturer: *Corona Data Systems*

System Model: PCHD1

CPU/Clock Speed: 8088 @ 4.77 MHz

Min.-Max. Memory: 128 to 512 Kb

Ports:
- RS232 1
- Parallel 1

Expansion Slots: 4

Mass Data Storage:
- Max. Floppy Drives/Capacity (Kb) 1 @ 350 Kb
- Max. Hard Disk Drives/Capacity (Mb) 1 @ 10 Mb

Operating System: MS-DOS, CP/M-86

System Cost: $3850

Included Equipment:
- Hardware: CPU, 128 Kb; one 360-Kb diskette drive, one 10-Mb hard disk, monitor, keyboard
- Software: MS-DOS 2.0, GWBasic, Multimate, PC Tutor

Table B1 (Cont'd)

Manufacturer: *DEC*

System Model: Rainbow 100+

CPU/Clock Speed: Zilog Z80 @ 4.0, 8088 @ 4.77 MHz

Min.-Max. Memory: 64 to 896 Kb

Ports:

RS232	2
Parallel	0

Expansion Slots: 2

Mass Data Storage:

Max. Floppy Drives/Capacity (Kb)	4 @ 400 Kb
Max. Hard Disk Drives/Capacity (Mb)	1 @ 10 Mb

Operating System: CP/M-80, CP/M-86, MS-DOS

System Cost: $5475

Included Equipment:

Hardware	Dual CPUs, 128Kb; two 400-Kb diskette drives, one 10-Mb hard disk
Software	None

Note: Dual CPUs are 8-bit and 16-bit. Monitor and keyboard sold separately.

Manufacturer: *Eagle Computer, Inc.*

System Model: 1630

CPU/Clock Speed: 8086 @ 8 MHz

Min.-Max. Memory: 128 to 512 Kb

Ports:

RS232	2
Parallel	1

Expansion Slots: 8

Mass Data Storage:

Max. Floppy Drives/Capacity (Kb)	2 @ 780 Kb
Max. Hard Disk Drives/Capacity (Mb)	1 @ 10 Mb

Operating System: MS-DOS, CP/M-86, MP/M-86, Concurrent CP/M-86

System Cost: $6995

Included Equipment:

Hardware	CPU, 128 Kb; keyboard, monitor, one 780-Kb diskette, one 10-Mb hard disk
Software	Eagle Writer, Eagle Calc, CP/M-86, MS-DOS

Note: A 32-Mb hard disk model is also offered.

Table B1 (Cont'd)

Manufacturer: *IBM*

System Model: PC XT

CPU/Clock Speed: 8088 @ 4.77 MHz

Min.-Max. Memory: 128 to 640 Kb

Ports:
RS232 1
Parallel 1

Expansion Slots: 5

Mass Data Storage:
Max. Floppy Drives/Capacity (each) 2 @ 360 Kb
Max. Hard Disk Drives/Capacity (each) 2 @ 10 Mb

Operating System: PC-DOS, CP/M-86

System Cost: $6150

Included Equipment:
Hardware CPU, 256 Kb; one 10-Mb hard disk, one 360-Kb diskette, monochrome monitor, printer

Software None

Note: Operating system sold separately.

Manufacturer: *IBM*

System Model: PC AT

CPU/Clock Speed: 80286 @ 6 MHz

Min.-Max. Memory: 256 Kb to 3 Mb

Ports:
RS232 1
Parallel 1

Expansion Slots: 8

Mass Data Storage:
Max. Floppy Drives/Capacity (each) 2 @ 1.2 Mb
Max. Hard Disk Drives/Capacity (each) 2 @ 20 Mb

Operating System: PC-DOS 3.0, Xenix

System Cost: $5795

Included Equipment:

Hardware CPU, 256 Kb; one 1.2-Mb diskette drive, one 10-Mb hard disk, keyboard

Software None

Note: Price does not include monitor; the 80286 is a 16/24-bit CPU.

Table B1 (Cont'd)

Manufacturer: *ITT Information Systems*

System Model: ITT Xtra Model 3

CPU/Clock Speed: 8088 @ 4.77 MHz

Min.-Max. Memory: 128 to 640 Kb

Ports:
- RS232 1
- Parallel 1

Expansion Slots: 5

Mass Data Storage:
- Max. Floppy Drives/Capacity (Kb) 2 @ 360 Kb
- Max. Hard Disk Drives/Capacity (Mb) 1 @ 10 Mb

Operating System: ITT DOS 2.11

System Cost: $4995

Included Equipment:
- Hardware: CPU, 128 Kb; monitor, keyboard, one 360-Kb diskette drive, one 10-Mb hard disk
- Software: Operating System, ITT Advanced BASIC

Manufacturer: *NEC Information Systems*

System Model: APC III

CPU/Clock Speed: 8086 @ 8.0 MHz

Min.-Max. Memory: 128 to 512 Kb

Ports:
- RS232 1
- Parallel 1

Expansion Slots: 5

Mass Data Storage:
- Max. Floppy Drives/Capacity (Kb) 2 @ 1 Mb each
- Max. Hard Disk Drives/Capacity (Mb) 2 @ 10 Mb each

Operating System: CP/M-86, MS-DOS, UCSD p-System

System Cost: $4198

Included Equipment:
- Hardware: CPU, 128 Kb; two 1-Mb diskette drive, color monitor, keyboard
- Software: MS-DOS, CW BASIC

Note: System uses 8-in. floppy disks; hard disk is not included in cost.

Table B1 (Cont'd)

Manufacturer: *Radio Shack*

System Model: TRS-80 Model 2000

CPU/Clock Speed: 80186 @ 8 MHz

Min.-Max. Memory: 256 to 768 Kb

Ports:

RS232	1
Parallel	1

Expansion Slots: 4

Mass Data Storage:

Max. Floppy Drives/Capacity (Kb)	2 @ 720 Kb
Max. Hard Disk Drives/Capacity (Mb)	1 @ 10 Mb

Operating System: MS-DOS 2.0

System Cost: $4500

Included Equipment:

Hardware	CPU, 256 Kb; monitor, keyboard, one 10-Mb hard disk, one 720-Kb diskette drive
Software	MS-DOS, MS-GW BASIC

Note: Quad-density 5 1/4-in. floppy diskette is used.

Manufacturer: *Radio Shack*

System Model: TRS-80 Model 16B

CPU/Clock Speed: MC 68000 @ 16 MHz, Z80A @ 4 MHz

Min.-Max. Memory: 256 to 768 Kb

Ports:

RS232	2
Parallel	1

Expansion Slots: 4

Mass Data Storage:

Max. Floppy Drives/Capacity (Kb)	2 @ 1.25 Mb
Max. Hard Disk Drives/Capacity (Mb)	4 @ 15 Mb each

Operating System: TRSDOS, Xenix

System Cost: $6499

Included Equipment:

Hardware	CPU, 256 Kb; monitor, keyboard, one 1.25-Mb diskette drive, one 15-Mb hard disk.
Software	TRSDOS, BASIC

Note: Dual processor, uses 8-in. floppy diskettes; Xenix operating system allows up to three users to perform simultaneous tasks.

Table B1 (Cont'd)

Manufacturer: *Seequa Computer*

System Model: XT

CPU/Clock Speed: Z80A @ 2.5 MHz and 8088 @ 4.77 MHz

Min.-Max. Memory: 256 to 640 Kb

Ports:

RS232	1
Parallel	1

Expansion Slots: 5

Mass Data Storage:

Max. Floppy Drives/Capacity (Kb)	1 @ 320/360 Kb
Max. Hard Disk Drives/Capacity (Mb)	1 @ 10 Mb

Operating System: MS-DOS 2.1, CP/M-86, Concurrent CP/M-86 and CP/M-80

System Cost: $3995

Included Equipment:

Hardware	CPU, 256 Kb; keyboard, one 320-/360-Kb diskette drive, one 10-Mb hard disk
Software	MS-DOS, Perfect Writer, Perfect Calc, Condor-I, C-term and GW BASIC

Note: Dual CPU; price does not include monitor.

Manufacturer: *Televideo Systems, Inc.*

System Model: TS 1605H

CPU/Clock Speed: 8088 @ 4.77 MHz

Min.-Max. Memory: 128 to 256 Kb

Ports:

RS232	1
Parallel	1

Expansion Slots: 1

Mass Data Storage:

Max. Floppy Drives/Capacity (Kb)	2 @ 368 Kb or 737 Kb
Max. Hard Disk Drives/Capacity (Mb)	2 @ 10 Mb

Operating System: CP/M-86, TeleDOS, Concurrent CP/M

System Cost: $6590

Included Equipment:

Hardware	CPU, 260 Kb; monitor, keyboard, one 360-Kb diskette drive, one 10-Mb hard disk, printer
Software	TeleDOS, TeleBASIC

Table B1 (Cont'd)

Manufacturer: *Zenith*

System Model: Z-120

CPU/Clock Speed: 8085 @ 4.77 MHz & 8088 @ 4.77 MHz

Min.-Max. Memory: 128 to 768 Kb

Ports:

RS232	2
Parallel	1

Expansion Slots: 4

Mass Data Storage:

DMA	
Max. Floppy Drives/Capacity (Kb)	2 @ 320 Kb
Max. Hard Disk Drives/Capacity (Mb)	1 @ 11.3 Mb

Operating System: CP/M-85, Z-DOS

System Cost: $5499

Included Equipment:

Hardware	CPU, 192 Kb; monitor, keyboard, one 320-Kb diskette drive, one 11.3-Mb hard disk
Software	Z-DOS, Multiplan, BASIC, Z-BASIC, CP/M-86

Note: Dual processor; includes color graphics capabilities.

Table B2

Microcomputer Manufacturer Information

AT&T Information Systems
100 Southgate Parkway
Morristown, NJ 07960
(201) 898-8000

Columbia Data Products, Inc.
9150-D Rumsey Road
Columbia, MD 21045
(301) 992-3400

Compaq Computer Corp.
20222 FM 149
Houston, TX 77070
(713) 370-7040

Corona Data Systems
275 Hillcrest Drive
Thousand Oaks, CA 91360
(805) 495-5800

Digital Equipment Corp.
146 Main Street
Maynard, MA 07145
(617) 897-5111

Eagle Computer
983 University Avenue
Los Gatos, CA 95030
(408) 395-5005

IBM Corp.
Old Orchard Road
Armonk, NY 10504

ITT Information Systems
P.O. Box 52106
Phoenix, AZ 85072
(800) 321-9872

NEC Information Systems
5 Militia Drive
Lexington, MA 02173
(617) 862-3120

Radio Shack, a Division of
Tandy Corp.
1300 One Tandy Center
Fort Worth, TX 76102
(817) 390-3330

Seequa Computer Corp.
8305 Telegraph Road
Odenton, MD 21113

Televideo Systems, Inc.
1170 Morse Avenue
Sunnyvale, CA 94086
(408) 745-7760

Zenith Radio Corp.
Zenith Data Systems
Division
1000 Milwaukee Avenue
Glenview, IL 60025
(312) 391-8860

Table B3

Monitors

Terminal	Resolution (Dots per in.)	Lines X Character	Display*	List Price, $
Amdek Corp.				
Model 300/300A	260 x 300	24 x 80	G,A	189
Color II Plus	640 x 240	24 x 80	C	559
Micro Display Systems				
The Genius 102	800 x 720	57 x 80	B/W,G,A	1395
NEC				
JC-121DFA	640 x 240	25 x 80	C	599
Panasonic				
TR-120MPDA	1100**	25 x 80	G,A	240
DT-H103	760 x 570	25 x 80	C	753
Princeton Graphics Sys.				
MAX-12	720 x 350	25 x 80	A	249
HX-12	690 x 240/280	25 x 80	C	695
SR-12	690 x 480	25 x 80	C	799
Quadram Corp.				
Quadchrome	690 x 480	25 x 80	C	795
Sakata				
SG-1000	Unknown	25 x 80	G	129
SC-200	640 x 240	25 x 80	C	649
Taxan				
KX-12	1000 x 360	25 x 80	G,A	230
RGBvision 420	640 x 262	25 x 80	C	650
Zenith				
ZVM-135	640 x 240/480	25 x 80	C	599

*A-Amber, B/W-Black & White, C-Color, G-Green
**Lines center resolution

Table B4

Keyboards

Vendor	Model	List Price, $
Colby Computer	Key-2	260
Keytronic Corp.	KB 5150	209
	KB 5150H	209
	KB 5151	255
Maxi-Switch Co.	8505	210
	8506	210

Table B5

Letter Quality Printers

Printer	Printing Rate*	List Price, $
C. Itoh Electronics F-10/55	55	2320
Computers International Daisywriter 2000	40	1645
Dataproducts Corp. DP 55	55	2610
Diablo Systems, Inc. 630 ECS	40	2745
Fujitsu America Inc. SP830	80	3145
NEC Information Systems, Inc. 3550	35	2410
Qume Corp.		
Sprint 11/40	40	1681
Sprint 11/55	55	1895
Ricoh of America, Inc.		
RP 1500Q	40	1800
RP 16000	50	2700

*Characters per second.

Table B6

Modems

Modem	Baud Rate	Connection	Functions*	List Price, $
Bytcom 212 AD	300/1200	direct	A,D,R	695
Codex 220 Modem	1200/2400	direct	A	1195
DEC DF03	300/1200	direct	A,D,R	1095
Hayes Smartmodem 1200	300/1200	direct	A,D,R	699
Hayes Smartmodem 1200B	300/1200	plug-in board	A,D,R	599
Omnitec Data 8212 AD	300/1200	direct	A,D,R	650
Omnitec Data 9212 OAA	300/1200	direct	A,D,R	785
Racal Vadic VA212	300/1200	direct	A,D,R	695
Rixon R212A	300/1200	direct	A,D,R	499
Universal Data Systems 212A	300/1200	direct	A,D	675

*A - Automatic Answer; D - Automatic Dial; R - Re-dial Stored Numbers

Table B7

Dot-Matrix Printers

Printer	Speeds*	Graphics Resolution**	# of Pins	List Price, $
Anadex				
WP6000	280/200/150	144 x 144	18	2700
DP6500	500/250/110	144 x 144	18	2995
DP9625B	240/100/60	144 x 144	18	1500
Centronics Data Computer				
351	200/65	66 x 72	9	2195
353	200/50	66 x 72	9	2495
358	400/100	66 x 72	18	3150
C. Itoh Electronics				
CI-300	660/176	144 x 200	-	4495
CI-600	1320/374	144 x 200	-	5995
Dataproducts Corp.***				
P80	200/110	84 x 84	9	1299
P132	200/110	84 x 84	9	1499
Epson America, Inc.				
LQ-1500	200/67	120 x 180	24	1395
Genicom				
3024	200/100/40	204 x 144	9	1499
3304	300/200/100	72 x 72	18	2490
3404	400/100	72 x 72	18	2650
Mannesmann Tally				
MT1800	200/50	100 x 144	8	1995
MT440L	400/100	100 x 70	9	2595
NEC				
Pinwriter P2	180/90/35	120 x 120	18	799
Pinwriter P3	180/90/35	120 x 120	18	1150
Okidata				
Microline 84	200/100/50	72 x 103	9	1395
Pacemark 2410	350/175/85	144 x 144	9	2995

*Characters per second.
**Pins per inch.
***Formerly IDS Prism product line.

Table B8

Local Area Networks

Local Area Network	Medium	Access Method	Maximum No. Stations	Price per Station, $
AT&T Information Systems				
3B Net	Baseband	CSMA/CD	*	*
Cadlinc Inc.	Baseband	CSMA/CD	1024	3000
Corvus Systems Inc.				
Omninet	Baseband	CSMA/CD	64	495
CR Computer Systems Inc.				
X-Net	Twisted Pair	Polling	2032	1000
Davong Systems Inc.				
Multilink	Baseband	TP	255	700
Digital Microsystems Inc.				
HiNet/HiDos	Baseband	SDLC	32	1695
Dy-4 Systems Inc.				
DYNASTY	Baseband	CSMA/CD	64	1890
Fox Research Inc.				
10-NET	Twisted pair	CSMA/CD	U	695
Gateway Commun. Inc.				
G/NET PC-LNIM	Baseband	CSMA/CD	255	595
G/NET WNIM	Baseband	CSMA/CD	255	695
IBM Corp.				
IBM PC Cluster	Broadband	CSMA/CD	64	545
IDE Associates Inc.				
IDEAnet	Baseband	CSMA/CD	50	545
Magnolia Microsystems				
MAGNet	Baseband	TP	64	695
NCR Corp.				
Decision NET	Baseband	CSMA/CD	64	600
Nestar Systems Inc.				
PLANSeries	Baseband	TP	255	595
Novell Inc.				
NetWare/S	Twisted pair	Proprietary	24	250
NetWare/X	Broadband	Proprietary	64	U

Table B8 (Cont'd)

Local Area Network	Medium	Access Method	Maximum No. Stations	Price per Station, $
Orchid Technology PCnet	Broadband	CSMA/CD	256	745
Pragmatronics Inc. TIENET	Baseband	CSMA/CD	24000	636
Santa Clara Systems PC Net	Baseband	CSMA/CD	64000	695
Texas Instruments EtherSeries	Baseband	CSMA/CD	1000	899
3Com EtherSeries	Baseband	CSMA/CD	1024	795
Ungermann-Bass NET/ONE	Broadband	CSMA/CD	36000	575
VLSI Networks Inc. LINC	Baseband	TP	32	349
Xyplex Inc. The Xyplex System	Baseband	CSMA/CD	1000	350

*Unknown.

Table B9

Vendors of Power Protection Devices

Vendor	Telephone Number
Clary Corp.	(818) 287-6111
Computer Accessories Corp.	(619) 695-3773
Computer Power Products	(213) 277-6937
Computer Power Inc.	(201) 735-8000
Control Concepts Corp.	(607) 724-2484
Electronic Protection Devices	(800) 343-1813
Electronics, Inc.	(516) 586-5125
Exlin	(619) 571-3134
Kensington Microware Ltd.	(212) 486-7707
NFSI	(800) 345-1280
Panamax	(415) 472-5547
RTE Deltech, Inc.	(619) 291-4211
Saft America	(602) 894-9564
Sola	(312) 439-2800
Topaz Inc.	(619) 279-0831
Unitron, Inc.	(214) 271-4531

APPENDIX C:

LISTING OF AVAILABLE SOFTWARE

This appendix lists a variety of proprietary software packages which are commercially available for use in field offices. Table C1 presents a detailed list of some of the recommended project management systems. Tables C2 through C6 present lists of software which are suitable for use in field offices. The prices listed are suggested retail prices. The cost of these packages when purchased through the Federal supply schedule will be reduced by 15 to 40 percent.

Table C1

Project Management Systems

Program Name:	Plan Trac
Vendor/Address:	Computerline 95 Merrymount Road Quincy, MA 02169
Telephone:	617/773-0001
Operating System:	TRS DOS, CP/M, MS-DOS
Maximum No. of Activities/Project:	62,500
Arrow/Precedence Notation:	Both
Sort/Select Report Writer:	Sort and Select
Super/Sub Networks:	Yes
Price:	$3000 initial purchase $1000 each subsequent year
Comments:	*A very complete network analysis system. Handles both* costs and resource management, with 200 resources per project.

Program Name:	AlderGraf
Vendor/Address:	Alderfer Project Control Services, Inc. 1080 West Belt North, Suite 240 Houston, TX 77043
Telephone:	713/467-8500
Operating System:	MS-DOS
Maximum No. of Activities/Project:	5,000
Arrow/Precedence Notation:	Both
Sort/Select Report Writer:	Limited sort and select
Super/Sub Networks:	Unknown
Price:	$2800
Comments:	An additional package provides time-scaled plot of network diagrams.

Table C1 (Cont'd)

Program Name:	Primavera Project Planner
Vendor/Address:	Primavera Systems, Inc. 29 Bala Avenue, Suite 224 Bala Cynwyd, PA 19004
Telephone:	215/667-8600
Operating System:	MS-DOS
Maximum No. of Activities/Project:	10,000
Arrow/Precedence Notation:	Both
Sort/Select Report Writer:	Sort and select
Super/Sub Networks:	Yes
Price:	$2500
Comments:	Minimum memory of 512 Kb required. Performs limited resource levelling, 96 resources per project.

Program Name:	PMS-II
Vendor/Address:	North America Mica, Inc. Suite 240 11772 Sorrento Valley Rd. San Diego, CA 92121
Telephone:	714/481-6998
Operating System:	CP/M-80, CP/M-86, MS-DOS
Maximum No. of Activities/Project:	2,500
Arrow/Precedence Notation:	Arrow only
Sort/Select Report Writer:	Sort and select
Super/Sub Networks:	Yes
Price:	$1295
Comments:	Resource allocation module available.

Table C1 (Cont'd)

Program Name:	PMS-80
Vendor/Address:	Pinnell Engineering 5331 SW Macadam Ave. Suite 270 Portland, OR 97201
Telephone:	503/243-2246
Operating System:	CP/M, MP/M, MS-DOS*
Maximum No. of Activities/Project:	1,000 10,000 w/hard disk
Arrow/Precedence Notation:	Both
Sort/Select Report Writer:	Sort and select
Super/Sub Networks:	Yes
Price:	$995
Comments:	Additional options for resource management and cost tracking are available.

*MS-DOS version requires the Baby Blue expansion board.

Program Name:	PERTmaster
Vendor/Address:	Westminster Software 300 Sand Hill Road Bldg 4, Suite 245 Menlo Park, CA 94025
Telephone:	415/854-1400
Operating System:	MS-DOS, CP/M-80, TRS-DOS
Maximum No. of Activities/Project:	2,500
Arrow/Precedence Notation:	Both
Sort/Select Report Writer:	Limited sort and select
Super/Sub Networks:	Unknown
Price:	$895
Comments:	Does not implement true PERT analysis.

Table C1 (Cont'd)

Program Name:	Micro Trak
Vendor/Address:	Softrack Systems 1977 West North Temple P.O. Box 22156 AMF Salt Lake City, Utah 84122
Telephone:	801/531-8550
Operating System:	CP/M, MS-DOS, Z-DOS
Maximum No. of Activities/Project:	5,000
Arrow/Precedence Notation:	Precedence Only
Sort/Select Report Writer:	Limited sort and select
Super/Sub Networks:	No
Price:	$595
Comments:	Other modules include cost and resource management packages.

Program Name:	Harvard Project Manager
Vendor/Address:	Harvard Software, Inc. 521 Great Road Littleton, MA 01460
Telephone:	617/486-8431
Operating System:	MS-DOS
Maximum No. of Activities/Project:	200
Arrow/Precedence Notation:	Arrow only
Sort/Select Report Writer:	No
Super/Sub Networks:	No
Price:	$395
Comments:	Intended for simple applications.

Table C2

Data Base Management Programs

	System Requirements	Menu Driven	Command Driven	Max. Characters per Field	Max. Characters per Record	Max. Fields per Record	Max. Records per File	No. of Field Types	Simultaneous Sorting on Multiple Fields	Reads/Writes Diff. Files	Reads/Writes ASCII Files	Price
Condor 3 Condor Computer Co. 2051 S. State St. Ann Arbor, MI 48104 313/769-3988	80K, 1 Drive	Yes	Yes	127	1024	127	65534	5	Yes	No	Yes	$650
dBASE II Ashton-Tate 10150 W. Jefferson Blvd. Culver City, CA 90230 213/204-5570	128K, 2 Drives	No	Yes	254	1000	32	65535	3	Yes	Yes	No	$700
dBASE III Ashton-Tate 10150 W. Jefferson Blvd. Culver City, CA 90230 213/204-5570	256K, 2 Drives	No	Yes	254	4000	127	Unlimited	4	Yes	No	Yes	$695
Friday! Ashton-Tate 10150 W. Jefferson Blvd. Culver City, CA 90230 213/204-5570	64K, 2 Drives	Yes	No	32	999	32	65535	5	Yes	No	Yes	$295
Omnifile SSR Corporation 1600 Lyell Avenue Rochester, NY 14606 716/254-3200	192K, 2 Drives	Yes	No	1828	12032	100	Unlimited	3	Yes	Yes	Yes	$425
Pfs:File/Pfs:Report Software Publishing Corp. 1901 Landings Drive Mountain View, CA 94043 415/962-0191	64K, 1 Drive	Yes	No	1679	Unlimited	3200	Unlimited	*	Yes	No	Write Only	$265
Power-base GMS Systems 12 W. 37th St. New York, NY 10018 212/947-3590	256K, 2 Drives	Yes	No	80	1600	64	65534	5	No	No	Yes	$395
R:base 4000 Microrim, Inc. 1750 112th Avenue, N.E. Bellevue, WA 98004 206/453-6017	256K, 2 Drives	Yes	Yes	1500	1500	400	Unlimited	6	Yes	Yes	Yes	$495
T.I.M. IV Innovative Software, Inc. 9300 W. 110th St. Overland Park, KS 66210 913/383-1089	128K, 2 Drives	Yes	No	60	2400	40	32767	5	Yes	Yes	Yes	$495
Knowledge Manager Micro Data Base Sys., Inc. P.O. Box 248 Lafayette, IN 47902 317/463-2581	192K, 2 Drives	No	Yes	65535	65535	255	65535	Unknown	Unknown	Unknown	Yes	$500

Table C3

Word Processing Programs

	System Requirements	Screen Format Printed Exactly as Seen	Includes Spelling Checker	Includes Mail-Merge Features	On-Screen Help	Undo Last Command	Work With Database Generated Lists	Limited Math Functions	Column Move	Multiple Line Headers	Multiple Line Footnotes	Price
Microsoft Word Microsoft Corporation 10700 Northrup Way Bellevue, WA 98004 206/828-8080	128K, 1 Drive	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	$375
Multimate Softword Systems, Inc. 52 Oakland Avenue North East Hartford, CT 06108 800/243-4646	192K, 2 Drives	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	$495
OfficeWriter Office Solutions, Inc. P.O. Box 5146 Madison, WI 53705 608/274-5047	192K, 2 Drives	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	$325
PeachText 5000 Peachtree Software 3445 Peachtree Road, NE Atlanta, GA 30326 404/239-3000	128K, 1 Drive	No	Yes	Yes	Yes	No	No	No	No	Yes	Yes	$395
Perfect Writer Perfect Software, Inc. 1001 Camelia Street Berkeley, CA 94710 415/527-2626	64K, 1 Drive	Yes	No	No	Yes	Yes	Yes	No	No	Yes	Yes	$350
Pfs:Write Software Publishing Corp. 1901 Landings Drive Mountain View, CA 94043 415/962-8910	128K, 1 Drive	Yes	No	No	Yes	No	No	No	No	Yes	Yes	$140
Volkswriter Deluxe Lifetree Software, Inc. 411 Pacific Street, Suite 315 Monterey, CA 93940 408/373-4719	128K, 2 Drives	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	$285
WordPerfect Satellite Software International 288 West Center Street Orem, UT 84057 801/224-8554	128K, 2 Drives	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	$495
WordStar MicroPro International Corp. 33 San Pablo Avenue San Rafael, CA 94903 415/499-1200	64K, 2 Drives	Yes	No	No	Yes	No	Yes	No	Yes	No	No	$495

Table C4

Electronic Spreadsheet Programs

	System Requirements	Maximum Rows	Maximum Columns	Standard Deviation/Variance Calculations	Linear Regression	Date Arithmetic	Block Manipulations	Graphics Capability	Price
InteCalc Intesoft/Schuchardt Software Systems 515 Northgate Drive San Rafael, CA 94903 415/492-9330	128K, 1 Drive	255	255	Yes	Yes	Yes	Yes	No	$295
Lotus 1-2-3 Lotus Development Corp. 161 First Street Cambridge, MA 02142 617/492-7870	192K, 1 Drive	2048	256	Yes	No	Yes	Yes	Yes	$495
Multiplan Microsoft 10700 Northrup Way Bellevue, WA 98004 206/828-8080	128K, 1 Drive	255	63	Yes	No	No	Yes	No	$195
PeachCalc Peachtree Software, Inc. 3445 Peachtree Road Atlanta, GA 30326 404/239-3000	64K, 2 Drives	254	63	No	No	No	Yes	No	$150
Report Manager Datamension Corp. 615 Academy Drive Northbrook, IL 60062 312/564-5060	128K, 2 Drives	255	255	Yes	Yes	Yes	Yes	No	$495
SuperCalc 3 Sorcim Corporation 2195 Fortune Drive San Jose, CA 95131 408/942-1727	96K, 2 Drives	254	63	No	No	Yes	Yes	Yes	$395
VisiCalc IV VisiCorp 2895 Zanker Road San Jose, CA 95134 408/946-9000	128K, 1 Drive	254	63	No	No	No	No	Yes	$250

Table C5

Integrated Software Programs

	System Requirements	Spreadsheet Module	Max. No. of Columns*	Max. No. of Rows*	DBMS Module	Word Processing Module	Graphics Module	Communication Module	Accepts Diff. Files	Accepts ASCII Files	Price
Corporate MBA Context Management Systems 23968 Hawthorne Blvd. Torrance, CA 90505 213/378-8277	384K	Yes	999	95	Yes	Yes	Yes	Yes	Yes	Yes	$895
Framework Ashton-Tate 10150 West Jefferson Blvd. Culver City, CA 90230 213/204-5570	256K	Yes	32000	32000	Yes	Yes	Yes	Yes	Yes	Yes	$700
Goldengate Caldinet Software, Inc. 400 Blue Hill Drive Westwood, MA 02090 617/329-7700	256K	Yes	256	2048	Yes	Yes	Yes	Yes	Yes	Yes	$995
Integrated 6 Mosaic Software, Inc. 1972 Massachusetts Ave. Cambridge, MA 02140 617/491-2434	320K	Yes	256	2048	Yes	Yes	Yes	Yes	Yes	Yes	$495
Ovation Ovation Technologies 770 Dedham St. Canton, MA 02021 617/821-1420	512K	Yes	702	10000	Yes	Yes	Yes	Yes	Yes	Yes	$795
Symphony Lotus Development Corp. 161 First St. Cambridge, MA 02142 617/492-7171	320K	Yes	256	8192	Yes	Yes	Yes	Yes	Yes	Yes	$695

*Dependent on available memory.

Table C6

Graphics Software

	System Requirements	Bar Charts	Line Charts	Pie Charts	Stacked Bar Charts	Gantt Charts	Organization Charts	Handles Text	Allows Drafting	Accepts Diff. Files	Accepts SYLK Files	Price
Boardroom Graphics Analytical Software, Inc. 10939 McCree Road Dallas, TX 75238 214/340-2564	128K, 1 Drive	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	$115
BPS Business Graphics Business and Professional Software, Inc. 143 Binney St. Cambridge, MA 02142 617/491-3377	128K, 2 Drives	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	$350
Chart Master Decision Resources, Inc. 25 Sylvan Road South Westport, CT 06880 203/222-1974	192K, 1 Drive	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	No	$375
DR Graph Digital Research, Inc. 160 Central Ave. Pacific Avenue, CA 93950 408/649-3896	128K, 2 Drives	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	$195
Fastgraphs Innovative Software, Inc. 9300 W. 110th St., Suite 380 Overland Park, KS 62210 913/383-1089	128K, 2 Drives	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	$295
GDSS Data Business Visions, Inc. 3510 Dunhill St., Suite B San Diego, CA 92121 619/450-1556	320K, 2 Drives	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	$1000
Graphwriter Graphic Communications, Inc. 200 Fifth Ave. Waltham, MA 02254 617/890-8778	128K, 2 Drives	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	$395

Table C7

Communications Software

Asynchronous Communications
IBM
1133 Westchester Ave.
White Plains, NY 10604
914/696-1900
Price: $180

Crosstalk
Microstuf, Inc.
1845 The Exchange, Suite 140
Atlanta, GA 30039
404/952-0267
Price: $195

SmarTerm
PerSoft, Inc.
2740 Ski Lane
Madison, WI 53713
608/233-1000
Price: $125

Transend
SSM Microcomputer Products, Inc.
2190 Paragon Dr.
San Jose, CA 95131
408/946-7400
Price: $149

APPENDIX D:

BLANK SELECTION PROCEDURE WORKSHEETS

Worksheet 1

Needs Assessment

Activity Category (Project Information)	Number of Projects		Average Per Project		Product
1. Contractor/ subcontractor info.	_____	x	_____	=	_____
2. Correspondence (letters & memos)	_____	x	_____	=	_____
3. Pending change orders	_____	x	_____	=	_____
4. Safety reports	_____	x	_____	=	_____
5. Inspection schedules	_____	x	_____	=	_____
6. Shop drawings	_____	x	_____	=	_____
7. _____	_____	x	_____	=	_____
8. _____	_____	x	_____	=	_____
9. _____	_____	x	_____	=	_____
			TOTAL		_____

TOTAL Total in nearest thousand _____ (A)

Critical Path Method

Total number of activities for all projects to the nearest thousand _____ (B)

Estimate of Required Storage

$$1.2 \left(\frac{\text{_____}}{\text{(A above)}} \times 0.350 + \frac{\text{_____}}{\text{(B above)}} \times 0.450 + 0.950 \right) = \text{_____} \quad \text{(C)}$$

Worksheet 2

System Evaluation

A. Hardware vendor's name: _____

System name: _____

Basic hardware price: _____ Quantity: _____

B. Optional software:

Qty	Vendor and software name	Price
___	_____	____
___	_____	____
___	_____	____
___	_____	____
___	_____	____
___	_____	____
___	_____	____
	Software Subtotal	____
	Basic Hardware Subtotal	____
	SYSTEM PURCHASE PRICE	____

C. Optional hardware:

Qty	Vendor and product name	Prices
___	_____	____
___	_____	____
___	_____	____
___	_____	____
___	_____	____
___	_____	____
___	_____	____
	Hardware Subtotal	____

D. Comments

E. Scoring matrix

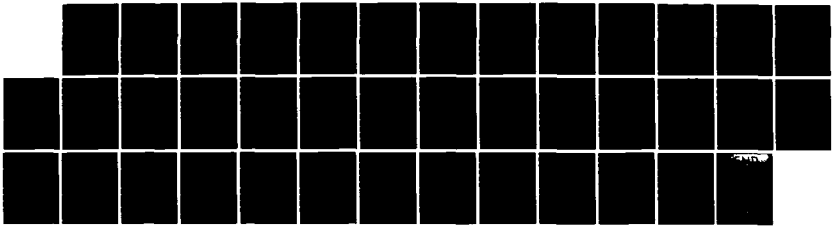
	Cost	Score (1-10)	Weight	Points
1. System Purchase				
2. Maintenance				
3. Training				
4. Performance				

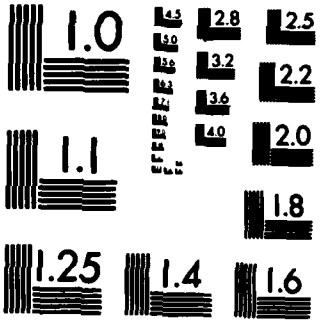
TOTAL COST =

TOTAL POINTS =

AD-A146 615 MICROCOMPUTER SELECTION GUIDE FOR CONSTRUCTION FIELD OFFICES REVISION(U) CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN IL M J O'CONNOR ET AL. SEP 84 2/2

UNCLASSIFIED TRP-146 F/G 9/2 NL





APPENDIX E:

EXAMPLE OF THE COST OF MAINTENANCE CONTRACTS

Microcomputer hardware maintenance contracts are available from a variety of sources with a variety of service. The sample prices shown here are for an IBM PC XT with one 10-Mbyte hard disk, one 5 1/4-in. diskette drive, a monochrome monitor, a keyboard, a Qume Spinwriter letter quality printer and an Okidata ML84 dot matrix printer. The cost of the service reflects prices charged in the Chicago area. The maintenance prices shown include parts, labor, and return shipment costs, if applicable.

Vendor A - A national service organization offering both on-call and depot maintenance.

Vendor B - A local computer firm offering on-call and depot maintenance as well as repair at an hourly rate without a maintenance contract.

1. The cost of a 1-year on-site maintenance contract:

   Vendor A - $972.60
   Vendor B - $951.50

2. The cost of a 1-year depot maintenance contract:

   Vendor A - $659.60
   Vendor B - $855.00

3. The cost of depot maintenance on an as-needed basis without a maintenance contract:

   Vendor A - Not offered
   Vendor B - $50.00/hr + parts

APPENDIX F:

GENERAL SERVICES ADMINISTRATION CONTRACTS

Background

The General Services Administration (GSA) has negotiated Multiple Award Schedule Contracts with many vendors of microcomputer hardware and software. These contracts are referred to as the Group 70, Part I, Sections A, B, and C Schedules. They offer Government agencies the opportunity to purchase microcomputer systems, accessorial items, and end user computers at approximately 15 to 20 percent below regular list prices. The list of products and vendors on these schedules is large and growing rapidly. It is anticipated that the few popular items that are not yet available through GSA will be in the near future.

According to ER 415-1-12, Section 6, para. c.(1) ..."field offices will use GSA Section C for the procurement of microcomputers whenever possible." In addition to getting a good price, you save procurement time by purchasing from a GSA contractor. Purchasing from a GSA contractor is considered competitive procurement, without the need for additional notice in the Commerce Business Daily or bid solicitation. Also, when you purchase from a GSA contractor you specify the exact make and model of the product(s), without the need for sole-source justification and approval.

Information and lists of contractors are available from:

General Services Administration
Office of Information Resources Management
ADP Schedules Contracts Branch (KESAS)
18th and F Streets NW
Washington, DC 20405
Phone: 202-566-19[illegible]

More conveniently, if you have access to a microcomputer equipped with a communications package and a 1200-baud modem, you may obtain the latest information and lists online, by dialing 202/535-7661. The menu-driven program is easy to use.

The GSA information is organized as follows:

- Group 70, Section A (Systems):
  - Contractor List
    - Contracts Awarded for FY84
    - Contracts Awarded for FY85
- Group 70, Section B (Accessorial Items):
  - Contractor List
- Group 70, Section C (End User Computer)
  - Computer Matrix
  - Manufacturers List
  - Computers by Contractor
  - Maintenance Contractors by Brand

Micro Software Contractors by Brand
Ordering and Payment Procedures

Since there is such a wealth of information which is easily obtained from GSA and because this information is constantly changing and being augmented, it will not be included here. Only the discussion of Ordering and Payment Procedures is included here because it demonstrates the ease with which procurement through the GSA contracts can be achieved.

Ordering and Payment Procedures

1. Agency selects make and model in accordance with internal regulations and Federal Procurement Regulations 1-4.1109-6 including the synopsizing of the notice of intent in the Commerce Business Daily, if over $50,000. No agency requirement in excess of $300,000 or maximum operating level, if lower, will be accepted under the Section C program.

2. Direct Ordering and Payment. Agency desiring to acquire end user computers, software, and maintenance may place orders directly with the contractors, and contractors will bill directly to the ordering agency unless the terms and conditions and ordering procedures of the contract stipulate otherwise. Contractors shall clearly indicate in their ADP Schedule Pricelist the ordering and billing instructions. If orders are required to be forwarded to GSA/OIRM the procedures set forth in paragraphs 3 through 9 apply.

3. Single Ordering and Payments. Agency orders if forwarded to GSA/OIRM, OIRM Procurement:

General Services Administration
Office of Information Resources Management
ADP Schedules Contracts Branch (KESAS)
18th and F Streets NW
Washington, DC 20405

a. Initial Procedure - order hard copy on purchase order form (SF 147, DD 1155, etc.). Original and three (3) copies of the order are required.

b. Document must include:

(1) Agency Order Number
(2) GSA Contract Number
(3) Make, Model, Quantity and Price (including software, documentations, training, etc.)
(4) Accounting and Appropriation Data
(5) Requisitioning Office
(6) Payment Office Agency Location Code (or address for DOD activities)
(7) Delivery Address
(8) Point of Contact (including telephone number)
(9) Signature of Official Authorized to Commit the Government

Note: As the program progresses, order entry will possibly be automated.

4. GSA/OIRM, OIRM Procurement will verify data and consolidate requisitions for order issue to contractors on a weekly basis. A Bulk Order, consisting of a cover letter and a copy of each agency purchase order, will be transmitted to the contractor. A copy of the Bulk Order, including attachments, will be retained by OIRM Procurement and a copy, with attachments, will be forwarded to ADP Fund.

5. Upon shipment, the contractor will issue invoices for each Bulk Order to GSA-OIRM-ADP fund. Invoices will include a copy of the bill of lading for shipments of equipment contained in the Bulk Order. Invoices will show the pricelist amount of the orders, a 1.5 percent single invoice discount amount, and the net invoice amount due.

6. GSA-OIRM-ADP Fund will verify invoices and submit to GSA Finance Office for payment in accordance with the Prompt Payment Act.

7. GSA Office of Finance pays the contractor the Agency order amount, less a 1.5 percent ordering processing charge.

8. GSA Finance Office will collect the full pricelist amount of the invoice from the Agency. Immediate reimbursement to GSA is required unless the Agency indicates that it has not received or accepted the equipment or supplies. In the absence of nondelivery notice, the ADP Fund will assume that all shipments have been received and accepted by the Agency. Agencies will not be required to forward receiving reports or analogous documents to the ADP Fund Branch as evidence of receipt. Agencies, however, must establish receiving report, and payment, and that equipment received is acceptable and in good condition, and immediately notify GSA of any problem or discrepancies.

9. GSA-OIRM-ADP Fund will act as the GSA Contracting Officer's Financial Representative and will resolve any problem concerning the receipt and acceptance of shipments, and will adjust billings and obtain credits as required.

APPENDIX G:

PERFORMANCE SPECIFICATIONS

The Sample Performance Specifications that follow relate to Standard Form 33, Solicitation, Offer, and Award.

Part I, Section C: Description/Specifications
Part I, Section E: Inspection and Acceptance
Part I, Section F: Deliveries and Performance
Part IV, Section M: Evaluation Factors for Award

The sample is intended as a guide only, and does not constitute complete SF-33 documentation. As any other sample or guide specification, this one will require editing and augmenting to meet the user's specific requirements. Likewise the items indicated for procurement with the sample specifications are examples only, and should not be construed as representing the specific needs of any field office.

PART I - SECTION "C"

DESCRIPTION/SPECIFICATIONS
FOR
MICROCOMPUTER SYSTEM(S) TO SUPPORT U.S. ARMY CORPS OF ENGINEERS FIELD OFFICES

1. GENERAL REQUIREMENTS

a. Purpose

The purpose of this procurement is the acquisition and installation of a microcomputer-based project and office management system at:

U.S. Army, Corps of Engineers
Muddy River Resident Office
17 Levee Road
River City, IA 12345-7890

The system shall consist of the following:

Hardware:
- 4 Microcomputer Processing Units
- 4 Monitors
- 4 Keyboards
- 2 Dot Matrix Printers
- 1 Letter Quality Printer
- 1 Modem
- 1 Centrally Shared Disk
- 1 Local Area Network

Software:
- Data Base Management System
- Spread Sheet
- Project Management System

Word Processing System
Communications
Operating System
Network Server

The contractor shall furnish all labor, materials, equipment, and services necessary for the installation and testing of the system. Detailed performance requirements are described starting in para 2.

b. Technical Proposals

Proposals shall provide an explicit description of all the hardware and software, that clearly indicates that the offered system meets the criteria set forth herein.

c. Evaluation and Contract Award

The offers shall be evaluated according to the criteria stated in Section M. Before the contract is awarded, the finalist(s) in this evaluation may be required, at the Government's option, to furnish all user's manuals and system's documentation for inspection. All such materials will be returned to the offerors after contract award.

d. Installation, Testing and Acceptance

The delivery, installation, and testing schedules shall be in accordance with Section F, and are to be approved by the Government. The contractor shall perform tests under Government review, as specified in Section E, "Acceptance Test." The acceptance test will be performed after installation at the Government site.

The bid price shall include all costs, except the Government will provide electrical power (115 V, 60 Hz, 20 amp). The contractor shall provide and install the system as required in Section C3, "Hardware and Software Specifications."

The contractor shall provide for each system two sets of documentation on each item of hardware and software, and all peripherals. The contractor shall provide the Government with a written certification, for each software package, stating that all copyrights of each software developer have been honored by the contractor.

e. Training

The contractor is not required to provide user training, EXCEPT ORIENTATION DURING THE ACCEPTANCE TEST.

f. Warranty and Maintenance

All hardware components shall be covered by the most favorable customary vendor warranties for such items. Thereafter the system will be maintained at Government expense. Upon delivery, the contractor shall provide the Government with a written statement as to when the warranty expires for each item.

Software packages shall be maintained, updated, and enhanced free of charge as is customary for each software vendor.

Maintenance of the offered hardware system must be available through the hardware vendor's own established support program, or through an established national service organization. However, the maintenance itself is not part of this procurement.

2. HARDWARE AND SOFTWARE SPECIFICATIONS

a. Hardware

The system shall consist of the following new components:

(1) Four work stations, each consisting of:

(a) One CPU: 16-bit microcomputer, with at least 256-Kb RAM, two serial and two parallel ports (RS232), with either PC-DOS or MS-DOS and CP/M-86 operating systems, and four expansion slots after installation.

(b) One Floppy Disk Drive: 5 1/4-in., 320 to 400 Kb.

(c) One Hard Disk Drive: 10 MB.

(d) One Monitor: CRT with 80 characters wide by 24 lines minimum, reverse video, addressable cursor, and true descenders.

(e) One Keyboard: Full ASCII upper and lower case, detachable, numeric keypad, programmable function keys consistent with software requirements.

(2) Two Dot Matrix Printers: 132-character carriage width, adjustable to accept 14 7/8-in. fan fold paper, standard friction feed and tractor feed, top of form and form length adjustment, selectable 10 to 16.7 pitch, underlining, overstriking, 1/2/3 line spacing, superscripts and subscripts, at least 180 characters/second.

(3) One Letter Quality Printer: Fully formed characters, 132-character carriage width, adjustable to accept 14 7/8-in. fan fold paper, standard friction feed and tractor feed, sheet feeder attachment, top of form and form length adjustment, selectable 10/12 pitch, underlining, overstriking, 1/2/3 spacing, superscripts and subscripts, at least 35 characters/second.

(4) One Modem: Asynchronous auto-dial/auto-answer, compatible with Bell 103/212A standards, selectable 300/1200 baud.

(5) Local Area Network: Host computer, centrally shared 20-MB disk, coaxial cables.

b. Software

(1) The operating system will include as a minimum CP/M-86 and PC-DOS or MS-DOS; a capability for later addition of the UNIX operating system is optional. The operating system must have the following minimum characteristics/capabilities:

(a) The system must be able to organize, schedule, and regulate the flow of work.

(b) The operating system must be able to catalog, create, copy, rename, and delete files. A screen oriented editor which features sort/merge functions and other utilities shall be included.

(c) The system must be capable of operating other vendor hardware peripherals such as modems and printers; at least one other manufacturer's modem and one other manufacturer's printer device must be supported in hardware and software.

(d) The system must be able to link precompiled routines.

(e) It should support auto-answer and auto-dial direct access telephone arrangements.

(f) It must have a higher-level language compiler (ANSI FORTRAN, ANSI FORTRAN 77), linker, loader and debugger, and compiler libraries (math, input/output merge/sort).

(g) The system must be documented. Operators/users manuals for hardware/software shall include all operations/commands and sample uses.

(h) The system shall prevent short-term character buffering losses due to output to slower devices (e.g. printer) or during disk input/output by a "read ahead" software function for all peripherals. Printer spooling shall be provided.

(i) Upon user task request, the system shall supply the current date and time.

(j) The operating system must include and support a file management system to include the following capabilities/facilities:

1. It must identify, allocate, store, protect, retrieve and dispose of files under user control.

2. The system should have language-independent files. Files created in one language must be accessible to other languages.

3. There must be sequential and random (direct) file access methods.

4. The system should use file commands that are device-independent or device-dependent at user option.

5. It should have the ability to store binary data and formatted data on magnetic disk.

6. For all disk files, the system should maintain and display accounting information such as the file name, size, location, access authorities, creation date/time, owner, and last access date/time.

7. It must save information about unusable disk areas detected by hardware. Information on faulty disk areas should be available.

8. The system must return storage space allocated to a purged file to the system for reallocation.

9. The system must provide the ability to change names and file protection status (e.g., read-only to write enabled) without copying.

(2) Project Management System Software

(a) The system must be interactive, user friendly, and lead the user through the steps to use the system. Interactive help, prompts, and menus of commands must be provided. Users manuals shall be provided. The users manuals shall document and describe each command and its parameters, and provide examples.

(b) The system shall complete the forward/backward pass calculations and all other required data processing of a typical network of 2000 activities in less than one (1) hour. If the I-J notation is used, dummies do not count as activities. System network processing speed will be a factor in contract award.

(c) System must be able to output results to standard ASCII files which can be accessed by the operating system editor. The system must be able to then transmit the results to the CRT screen and/or to an output device, port, or file.

(d) Overall features are:

1. Interactive data entry and command processing.

2. Menu-driven inputs for commands.

3. Addressable cursor for screen formatted inputs.

4. Input to the program either onto a screen form or through lines of specific prompted information.

5. Error checking of syntax and semantics on input.

6. If the system requires user-defined network size limits, then the system must provide a procedure to salvage network data when

size thresholds are reached so as to avoid manual re-entry of data into the larger size network space.

(e) The project management system must be capable of performing at least the following functions. Offers that exceed these minimum requirements (e.g., providing both I, J, and precedence notation) will earn additional credits in the evaluation process for contract award.

1. Network Analysis. The project management system shall be based on critical path type network analysis, and be able to accept data in I, J notation. Precedence notation is not required, but is highly desirable. The system shall be able to support the management of at least ten (10) concurrent projects. A maximum of 2000 activities per project is required.

2. Progress and Cost Reports. The project management system shall accept the current status of project activities (updating) and produce progress reports that compare the current status with the target schedule. The system shall also produce a partial payment estimate based on all completed work including partially completed activities. Cost reporting will include budgeted and actual cash flow reports.

3. Network Comparisons. The system shall enable the user to analyze the impact of changes on a schedule, by comparing a proposed schedule with an existing schedule. It shall produce a list of all activities that are affected by the proposed change, in addition to the information required for both schedules independently.

4. Super/Sub Networks. The system shall provide a means of handling subnetworks as part of a higher level network (fragnets or hammocking).

5. Resource Reporting. The system shall provide the capability to assign resources to activities and projects, and to track the resource utilization with appropriate reports. Automatic constrained resource scheduling and automatic resources leveling are not required.

6. Variable Calendar. The system shall accept 5-, 6-, or 7-day work weeks and be able to start a schedule on any calendar day. Variable holidays (up to ten (10) days), shutdowns and Julian and Gregorian calendar dates are required.

7. Loop Detection. Loop detection (multiple) is required if the occurrence of loops is not prevented by some input restriction (e.g., $I_n<J_n$).

8. Report Writer. The system shall include a report writer that allows flexibility in formatting and summarization of reports. Such reports shall be possible by sorting and selection of relevant activity attributes such as activity number, character code, duration, float, status, cost, date, or duration. Windowing (chronologically selected portions of the network) must be supported.

9. Graphical Output. Bar charts and networks printed by the dot matrix printer are required in daily and summarized weekly form.

(f) Required Features

Feature	Minimal Requirement
Network Features	
a. Activities per Project	2000
b. Relationships per Activity	20
c. Relationships per Network	6000
d. Activity Number	5 digits/characters
e. Activity Description	20 characters
f. Activity Sort/Select Code	6 characters
Input Features	
a. Input Format	Menu, screen forms
b. Input Edit	Error detection
c. Input Feasibility	Syntax and logical checks
d. Open Ends Detection (Listing of beginning/ending activities)	Required
e. Time Segments	Days, weeks
f. Error Override	No
g. Automatic File Maintenance	Required
Resourcing	
a. Editing of Resources	Required
b. Availability Profile	Summary lists
c. Resource Expenditure per Activity	Linear, lump
d. Utilization per Resource Type	Summary list
e. Utilization per Activity	Summary lists
f. Resources per Activity	6
g. Resources per Network	30

(3) Data Base Management Software Package

(a) The DBMS system must in essence conform to one of the following:

1. Technical Bulletin (TB) 18-103 requirements for a CODASYL based system, (Software Design and Development, Technical Bulletin (TB) 18-103 (Department of the Army, January 1983), Chapter 4).

2. A relational data base format as described in C. J. Date, An Introduction to Data Base Systems, 2nd Edition (Addison-Wesley, 1977).

(b) The DBMS must have the capability to perform data operations of addition, subtraction, multiplication, division, Julian and Gregorian calendar dates, and boolean algebra.

(c) The DBMS will be used to automate office data handling functions and to develop files to monitor various construction administration tasks. Descriptions of these DBMS applications are available upon request. Applications must be capable of writing designated data elements (Mission Data Elements) in ASCII format to a special file where they will be accessible for transfer over the District Wide Area Network. Similarily, these applications must access files for the inclusion of application data transferred from outside the Local Area Network.

(d) Required attributes are:

1. Allows users to develop their own data bases, input programs and reports.

2. CODASYL, Relational Calculus format, or data record management format.

3. The system shall provide interactive commands (control, data input, and report generation).

4. Screen layouts and command menus for inserting data.

5. Error checking of syntax and error processing.

6. Selectable formatted output for locating data and descriptions on pages of output.

(4) *Word Processing Package Software*

(a) System must have character, word, and line movement; deletion, insertion, and block movement; and in-line editing.

(b) System must have text formatting: overstriking; superscripts; subscripts; single-, double-, and triple-spacing; underlining; tabs; headers; footers; paragraphing; tables; justification (right, left, top, bottom); and pagination numbering.

(c) The word processing system must use brief and simple user command codes. It must be capable of handling uppercase/lowercase text. It must have a text formatting capability. The system must have special controls to avoid or recover undesired large deletions and to change errors.

(d) Required capabilities are:

1. Enter, change, move, and delete text.

2. List text and any part of text.

3. Margins (left, right, top, bottom), paragraphing, and pagination.

4. Generating multiple form letters with only address changes.

5. Headers/footers.

6. Merge text from other files.

7. Tables (column or row) entry.

(e) Desired capabilities are:

1. Word processor speller.

2. Compatibility between the word processor system and the Local and Wide Area Network electronic mail capability so that text developed in the word processor can be forwarded via electronic mail to any other station in the local or wide area network.

(5) Communications Software

(a) The software must support remote system interactive communication and bidirectional file transfer via the modem.

(b) The software must support terminal emulation and allow options such as full/half duplex, parity (even/odd and on/off), and character folding.

(c) The system will be capable of communicating with other computers, using xmodem protocol.

(d) The contractor shall supply full user documentation of the furnished software including the interchange protocols and a list of compatible systems.

(6) Local Area Network

Software and hardware as required to provide control of the network traffic. The network will include the four work stations, three printers, centrally shared hard disk, and modem; it must have expansion capability to handle two more work stations, at least two more peripheral devices, and another modem. The LAN shall be multiple-drop topology, using Carrier Sense Multiple Access with Collision Detection (CSMA/CD) protocol. The LAN shall include a centrally shared, 20-MB hard disk, the host microprocessor, and necessary cables, connections, and software. The LAN shall connect all workstations to the shared resources. Shared resources are all printers, modems, shared disks and other work stations.

(7) Spread Sheet

(a) Minimum features are:

1. Spreadsheet size up to 2048 rows by 256 columns

2. Variable column width adjustable column by column

3. Label formatting (centered, left-justified, right-justified, spill-over into adjacent cells)

4. Mathematical operators:

+
-
* (Multiplication)
/ (Division)

5. Logical operators:

= (Equal to)
< (Less than)
> (Greater than)
<> (Not equal to)
<= (Less than or equal to)
>= (Greater than or equal to)

6. Mathematical functions:

ABS (absolute value)
Round (value to the nth place)
INT (integer value of)
PI (value of PI 3.1417.....)

7. Statistical functions:

Count (the number of defined entries in the list)
Sum (the sum of values in a list)
Average (the average of defined entries in a list)
Minimum (over a range of cells)
Maximum (over a range of cells)
Standard deviation
Variance

8. Date and time functions

Date (day of the month)
Month (month of the year)
Year
Now (today's date)

9. Move, copy, delete, insert any cell range

10. Cursor movement to cells through function keys (up, down, left, right) or through coordinate designation

11. Electronic spreadsheet files will be accessible to other application packages without conversion or translation.

(b) Desirable features are:

1. Financial functions:

Future value
Internal rate of return
Net present value
Present value

2. Windows to view multiple portions of the spreadsheet

3. Date and time functions:

Hour
Minute
Second

4. Logical functions

5. Recalculation order control (row, column, natural)

6. Repeating labels

7. "Macros" or sets of commands executable by a single command.

(8) Software Integration/Compatibility

Full integration of the software packages is required as follows:

(a) The data base management system (DBMS) must be able to access output files of the project management, word processing, spreadsheet, and communication systems.

(b) The word processing system must be able to access and process files in the DBMS.

(c) The communications software must be able to access files in the DBMS.

(d) The graphics software must be able to retrieve files from the DBMS and the spreadsheet.

3. OPERATING ENVIRONMENT

The system is to be installed in a single story wood frame building, with gypsumboard ceilings and walls on wood studs and concrete floors. Available electrical power is 115 V, 60 Hz, 20a.

The system shall be capable of operating in ambient temperatures of 50 to 90°F and relative humidity of 20 to 95 percent.

Equipment components will be located in a number of rooms of the building, as specified by the government. LAN conductors shall be concealed above the ceiling or in the walls or much as possible. All components will be located within a rectangular area of approximately 150 x 100 ft.

Bidders are encouraged to inspect the installation site, where information on the location of the components within the building is available. Office hours are 0800 to 1630, Monday through Friday (except holidays). Site visits may be arranged by calling the Resident Engineer at (345) 768-1097.

4. MATERIALS AND SUPPLIES

During installation the system shall be made fully operational (i.e., one ribbon in each printer, adequate storage media to accommodate ten (10) projects of 2000 activities each and removable backup media for the same). In addition, the following shall be supplied by the contractor:

a. Paper required:

(1) Two boxes of 3000 pages each of blank letter size paper.

(2) Two boxes of 3000 pages each of continuous fan-fold blank paper in full printer size (14 7/8 in.).

b. Six ribbons for each printer.

PART I - SECTION "E"

INSPECTION AND ACCEPTANCE

1. INSPECTION AND ACCEPTANCE

The system to be furnished hereunder will be inspected and accepted at destination (this implements Clause 5, INSPECTION, of the contract General Provisions).* No payments will be made under this contract until the contractor has successfully performed the required acceptance testing.

2. BENCHMARK DATA

Packages with benchmark data are available and shall be mailed to all prospective offerors who have requested them. Inquiries should be sent to:

_____

_____

_____

*General Provisions (Supply Contract) Edition of 1 August 1980 issued by: Department of the Army, Corps of Engineers.

3. ACCEPTANCE TEST

After installation of the system at the Government site, the contractor shall conduct an acceptance test to demonstrate that the system, as installed, performs according to the specifications. The benchmark data shall be used for testing the Project Management System. The contractor shall prepare examples of specified management reports and forms as indicated by the Government.

The contractor shall demonstrate the project management reports with windowing. The contractor shall generate a report (sorted by I, J, or activity number) which selects all electrical activities which are due to late start between 18 February 1973 and 10 March 1973 in the benchmark CPM.

All hardware and software will be required to perform as specified.

If the system fails to meet the requirements in any of the tests, the Government may elect, at its option, to terminate the contract with no cost or obligation to the Government.

PART I - SECTION "F"

DELIVERIES AND PERFORMANCE

1. DELIVERY AND INSTALLATION SCHEDULE

No later than 2 weeks after the contract is awarded, but before the work is performed, the contractor shall submit a delivery, installation and testing schedule to the Government's contracting officer for approval.

2. CONTRACT PERIOD

All work covered by this contract shall be completed within 90 days after award of the contract.

3. DELIVERY TERMS

The systems to be furnished under this contract shall be delivered FOB Destination, to the addresses provided, with all transportation and installation costs paid for by the contractor.

4. INSTALLATION SITES

The system shall be installed at the following site:

U.S. Army Corps of Engineers
Muddy River Resident Office
17 Levee Road
River City, IA 12345-7890

PART IV - SECTION "M"

EVALUATION FACTORS AND AWARD

The bids will be evaluated by the Government on the four factors outlined below in the order of importance as listed. (NOTE: Factors b and c apply only to negotiated contracts.)

a. Bid/price.

b. The specifications in Section C establish the minimum acceptable level of performance. The manner in which each of the following requirements are met or exceeded will be evaluated:

1. System features and performance.

(a) Hardware
(b) Operating system
(c) Project management software
(d) DBMS
(e) Word processing software
(f) Electronic spreadsheet software
(g) Communications software
(h) Integration of hardware
(i) Local Area Network

2. Software Support

3. Warranty

c. The following features are desired, but not required. Offers that include these features will receive additional consideration.

1. Availability, convenience, and cost of maintenance.

2. Availability, quality, and cost of training,

3. The capability to accept network data in precedence notation.

4. Full multiple loop detection in network data without any restrictions on input conventions (to prevent loops).

5. Full integration between software packages, with data and files being passed automatically from one package to another as required.

6. Additional system software, compilers, and other software packages.

d. Submittals are required in support of the following:

1. Reputation of the offeror with respect to firm's technical competence and experience in developing or integrating and implementing software and hardware solutions to project management.

2. Experience in fielding a project management system within the last two years.

APPENDIX H:

NONCOMPETITIVE ACQUISITION OF ADP SYSTEM OR ADPE

SECTION I - IDENTIFIER

1. Assigned Responsible Agency: Army Environmental Office, USACE (DAEN-ZCE)

2. Title and Number of Data Processing Installation/Agency: Office of the Assistant Chief of Engineers.

3. Requiring Activity Representative: LT Steven D. Friederich, RPMS Integration and Planning Office (DAEN-ZCR).

SECTION II - ADP SYSTEM OR ADPE REQUIRED

4. Description of Requested System of ADPE:

HARDWARE

Qty.	Part No.	Item/Description	GSA Price	Est. Total	Annual Maint.
7	5150174	Basic System - IBM PC 64K RAM, Keyboard, 2 320-K Floppy Disk Drives with Adapters	1,843.	12,901.	2,352.
2	5160087	Basic System - IBM PC/XT 128K RAM, Keyboard, 1 350-K Floppy Disk Drive, 1 10-Mb Fixed Hard Disk with Adapters and Async	3,497.	6,994.	1,306.
9	5151001	Monochrome CRT	242.	2,178.	396.
7	FX-100	Printer, Maxtrix 160 cps	795.	5,565.	1,386.
7	1525612	Printer Cable	39.	273.	
7	1525614	Printer Stand	39.	273.	
9		USI Multidisplay Card	495.	4,455.	648.
7	1501013	64/128K RAM Expansion	116.	812.	532.
2	1501003	64/256K RAM Expansion	137.	274.	160.
2	3550	Nec Spinwriter Daisy Wheel Printer, 33 cps up to 203 columns	1,890.	3,780.	816.

HARDWARE (Cont'd)

Qty.	Part No.	Item/Description	GSA Price	Est. Total	Annual Maint.
2		Printer Cable	31.	62.	
2		Sheetfeeder, 180 sheets of 18 lb paper	890.	1,780.	400.
1		Compaq Portable computer with 256K RAM, 2 320-Kb Floppy disk drive, 9-in. display and RGB color interface	2,995.	2,995.	680.
1		Carrying Case, Compaq	65.	65.	
1		Hayes Smart modem	500.	500.	115.
9	3C500A	Etherlink Interface Card	850.	7,650.	720.
9	3C-530-007	Meter Cable	20.	180.	
		TOTAL		$50,737.	9,511.

SOFTWARE

Qty.	Part No.	Item/Description	GSA Price	Est. Total
3	6024035	CP/M 86	168.	504.
3	6024061	IBM DOS 2.0	42.	126.
1	6024037	3270 Emulation-Bisync	490.	490.
3		Select	296.	888.
1		PC/FOCUS	1,595.	1,595.
1		VisiOn (integrated package)	495.	495.
1		VisiOn mouse	295.	295.
1		Etherprint Software	500.	500.
		Ethershare Software	500.	500.
		TOTAL		$5,393.

5. Source Evaluation and Selection: The IBM PC and the PC-XT micros were selected for the following reasons: (1) compatibility, (2) ready availability of third party hardware, software, and maintenance, (3) superior communications capability, (4) availability of special applications development support. Many microcomputers were evaluated, and four met the requirements to some degree. A tabular comparison of the IBM and three other microcomputers is included for reference as Table H1 to this document. The comparison will clearly indicate IBM is the only micro that meets all the requirements.

Hardware application and software are the essential elements for choosing the appropriate micro. The IBM is compatible and will integrate with current Army systems, i.e., CAPCES, and the 1391 PROCESSOR and also has the flexibility to be compatible with future ADP systems such as VIABLE, STAMMIS, HOMES and HIOS. Third party support is by well-known, established companies such as TYMSHARE and 3COM. Special emulation software developed specifically for the PC/XT allows the IBM to communicate with many different types of mainframes and minicomputers.

SECTION III

6. Justification:

a. Hardware. There are several reasons for DAEN-ZCE's decision to acquire an automated task support system, and the IBM PC/XT. The justification, shown in Figure H1, can be summarized as follows: (1) the high ratio of processing power to cost, (2) labor saving potentials or cost avoidance, (3) quality and timeliness of data output, (4) the ability to minimize expensive local and remote mainframe connect time.

b. Software. Microcomputer based software is now comparable to minicomputer/mainframe software. Much more work can be done locally in a standalone mode. Formerly all work was done at terminals, which were connected to a mainframe in the old "star" configuration. This was very costly, concerning software development, and relatively inefficient compared to operating locally, as can be done now on micros. It is significant to note that access to mainframes is still needed in a micro environment for support. However, an on-site mainframe is not necessary. Remote access can be used to batch down needed information to the work station. Another important item to consider is the availability of formerly mainframe software in a micro version, i.e., SEED, IDMS and FOCUS.

The Army Environmental Office (ZCE) needs ten systems from which the following benefits are anticipated:

1. Cost - Displacement (reduction or avoidance). The Army Environmental Office reviews every Army regulation for environmental implications. ZCE also writes two lengthy documents, the OMB-A106 Report (1383) and the Defense Environmental Status Report. Presently these data are collected manually and are assembled by a contractor. ZCE receives regular status reports from installations, districts and MACOMs, which must be reviewed, with recommendations made. This again is done manually. The IBM PC/XT would drastically reduce the problems of handling such large amounts of data. ZCE could keep, on disks, many reference documents to aid in review, and also access the 1391

Table H1

CPU Comparison Chart

Scale	Points	IBM	Victor	Columbia	DEC
Integration Capability (20 Pts Possible)					
Support Fast Spooled Prt	0 or 2	2	0	0	0
Support Prt at Different Loc	0 or 3	3	3	3	0
Consistency of User Interface	0..4	3	2	2	2
Support for Large Jobs	0 or 4	4	4	4	4
Ease of Use	0..3	2	2	2	2
Integrated Office System	0..2	2	1	1	1
Integration of Existing Eqpt	0..2	1	0	0	1
	Total	17	12	12	10
Remote Access (20 Pts Possible)					
Focus Avail in Micro Version	0 or 5	5	0	0	0
No. of Lines to Tymshare (No.x2)	0 or 4	4	4	4	4
Edit Focus Offline and Upload	0 or 4	4	0	0	0
File Transfer	0 or 4	2	2	2	0
Access to Other Than Tymshare	0 or 2	2	2	2	2
Dir Connect to TYMNET Engine	0 or 2	2	2	2	2
Batch Access	0 or 1	1	1	1	1
	Total	20	11	11	9
Upgradability (16 Pts Possible)					
Expand Brd Slots: Up to 5; >5	1 or 2	2	1	2	1
RAM: 256, 512 and Over 512	1, 2, or 3	3	3	2	1
Hard Disk: 5, 10 and >10MB	1, 2 or 3	3	3	2	1
Processor Upgrade Potential	0..4	4	2	3	2
MSDOS and CP/M	0 or 3	3	3	3	3
Mainframe/Mini Interface	0 or 1	1	0	0	1
	Total	16	12	12	9
Third Party Support (16 Pts Possible)					
Hardware - Present	0..4	3	0	2	2
Software - Present	0..4	3	2	2	2
Hardware - Future	0..4	4	2	3	2
Software - Future	0..4	4	2	3	2
	Total	14	6	10	8
Stand-Alone Capability (10 Pts Possible)					
Hardware-Subjective Scale	0-3	3	1	2	2
Software-Subjective Scale	0-3	3	2	2	2
Shared File Access	0 or 2	2	2	2	0
Shared Dict, Formats, etc.	0 or 2	2	2	2	0
	Total	10	7	8	4

Table H1 (Cont'd)

Scale	Points	IBM	Victor	Columbia	DEC
Local Communications (8 Pts Possible)					
0 if None, 2 if Slow Coax, 4 if Fast Coax	0, 2 or 4	4	2	2	2
Standard ETHERNET	0 or 2	2	0	0	0
Unsync PC to PC Commo	0 or 2	2	2	2	2
	Total	8	4	4	4
Specialty Hardware (5 Pts Possible)					
Laser Printer, Controller, etc.	0 or 4	4	0	0	4
132 Column Display	0 or 1	1	1	1	1
	Total	5	1	1	5
Performance (5 Pts Possible)					
Subjective Assessment	0..5	4	3	3	3
	Totals	94	56	61	52

processor for MCA information. Currently ZCE cannot access the 1391 processor, because they lack any means to do so. Much time is lost in ZCE waiting for an available terminal to access 1391 data. ETIS, another system accessed by ZCE, is also used extensively. Here again, equipment of other offices within ACE must be used by ZCE to accomplish their mission. Saved labor time, terminal access and easily accessible information will justify the purchase of these systems. As much as $100,000 could be saved on labor time in the first year. Other savings will come as a result of efficient use of data by ZCE.

2. Value Added. Since ZCE speaks for the Army staff concerning environmental impact, the quality of data is very important. The officers of this division will have more time to qualitatively review and comment on environmental impacts of construction and other Army projects by automating with the aid of microcomputers. The time-consuming part of ZCE's mission, compiling environmental impact data, will allow the action officers to have more time to dedicate to review and to making recommendations.

3. New Capabilities. ZCE will have the following new capabilities: (a) access to high speed, letter quality printers, (b) enough terminals to access data sources, i.e., the 1391 processor and ETIS, and (c) electronically stored reference files to accelerate and add quality to the reviewing cycle.

	A	B	C	D	E	F	G
PERSONNEL	NUMBER	* AVERAGE SALARY $000	TOTAL EXPENSE $000 (AxB)	PERFORMANCE IMPROVE. %	OPPORTUN VALUE $000 (CxD)	EQUIP/ PERSON $000	TOT $000 INVESTMENT (AxF)
EXECUTIVES							
MANAGEMENT	1	76.9	76.9	10	7.7	10	10
PROFESS (ENGINEER)	7	59.5	416.5	20	83.3	20	140
PROFESS (OTHER)							
SUPPORT (SEC/TYP)	2	23.2	46.4	25	11.6	8	16
TOTALS	10	XXXXXX	539.8	XXXXXX	102.6	XXXXXX	166

H* TOT REVENUE $000

I REVENUE PER LABOR $ = H/C

J POTENTIAL REVENUE ADDED $ = (ExI)

HRS ACTUALLY WORKED

* AVG WAGE x 1880/2080 x (1.25)x(1.3)= B

HRS ACTUALLY PAID — FRINGES — OVERHEAD

*Office operating budget.

Figure H1. ZCE ADPE justification.

APPENDIX I:

ADDITIONAL SOURCES OF INFORMATION

Publications Rating and Evaluating Microcomputer Hardware and Software

Survey of CPM Scheduling Software Packages and Related Project Control Programs

The most complete survey on CPM project management software available. The Project Management Institute (PMI) has been conducting the survey every second year; most recent publication is dated October 1982.

Project Management Institute, P.O. Box 43, Drexel Hill, PA 19026, 215/622-1796, subscription: $12 (member), $14.50 (nonmember).

Construction Computer Applications Directory (CCAD)

The directory lists a large number of software packages in categories of interest to members of the construction industry. The contractor's needs are emphasized. Not much detail on the software packages is provided.

Construction Industry Press, 1105-F Spring Street, Silver Springs, MD 20910, 301/589-4884, subscription: $135/year (includes one update during the year).

Construction Computer Applications Newsletter (CCAN)

Reports on computer applications for construction activities and reviews computer packages.

Construction Industry Press, 1105-F Spring Street, Silver Springs, MD 20910, 301/589-4884, subscription: $60/year (12 issues).

Computers for Design and Construction

Reports bimonthly on computer applications for architectural and engineering design, and construction.

Meta Data, Inc., 441 Lexington Ave., New York, NY 10017, 212/687-3836, subscription: $48/year.

Data Decisions, Microcomputers

Comprehensive survey of microcomputer hardware, software, and peripherals. Includes results of hands-on evaluations and reports on current and emerging microcomputer technologies. Data Decisions, 20 Brace Road, Cherry Hill, NJ 08034, 609/429-7100.

The Ratings Book

The most complete publication on software performance based on test results obtained from the National Software Testing Center. Software Digest,

Inc., One Wynnewood Road, Wynnewood, PA 19096, 1-800-223-7093, $14.95 per issue, 10 issues per year and focusing on a different type of software. (Also available at many major bookstores.)

General Microcomputer Periodicals

Business Computer Systems

Focuses on current issues in office automation and microcomputer hardware and software. Cahners Publishing Company, Division of Reed Holdings, Inc., 221 Columbus Ave., Boston, MA 02116, 617/536-7780; free to business professional in charge of microcomputer procurement.

BYTE

Semi-technical microcomputer monthly. Byte Subscriptions, P.O. Box 590, Martinsville, NJ 08836, 808/258-5485, subscription: $21/year.

Computerworld

Computer-oriented weekly newspaper. Computerworld, Circulation Department, P.O. Box 897, Farmingham, MA 01701, 617/879-0700, subscription: $44/year.

Computer Decisions

Hayden Publishing Co., Inc., 50 Essex Street, Rochelle Park, NJ 07662, 201/843-0550.

Creative Computing

Personal and professional applications and reviews, monthly. Creative Computing, P.O. Box 789-M, Morristown, NJ 07960, 800/631-8112, subscription: $25/year.

Desktop Computing

Business and professional microcomputer magazine monthly. Desktop Computing, P.O. Box 917, Farmingdale, NY 11737, 603/924-9471, subscription: $25/year.

Dr. Dobbs Journal

General and technical information for the small computer user, monthly. Peoples Computer Company, 1263 El Camino Road, Menlo Park, CA 94025, 415/323-3111, subscription: $25/year.

InfoWorld

Small computer newspaper, weekly. InfoWorld, Circulation Department, P.O. Box 837, Farmingham, MA 01701, 617/879-0700, subscription: $31/year.

Interface Age

Business and personal computers, monthly. McPhebers, Wolfe, and Jones, 16704 Manquardt Ave., Cervitos, CA 90701, 213/926-9540, subscription: $21/year.

Microcomputing

Business, professional, and personal use of microcomputers, monthly. Wayne Green, Inc., 80 Pine St., Petersborough, NH 03458, 603/924-9471, subscription: $25/year.

Microsystems

Journal for users of the CP/M operating system, monthly. Microsystem Subscriptions, One Park Ave., New York, NY 10016, 800/631-8112, subscription: $25/year.

Mini/Micro Systems

Small computer magazine, monthly. Cahners Publishing Co., 270 S. Paul St., Denver, CO, 80206, 303/388-4511, subscription: $40/year, free to qualified subscribers.

Personal Computing

Personal and business microcomputers, monthly. Personal Computing, 50 Essex St., Rochelle Park, NJ 07662, 800/525-0643, subscription: $18/year.

Popular Computing

Personal and professional microcomputer magazine, monthly. Popular Computing, 70 Main St., Petersborough, NH 03458, 800/258-5485, subscription: $13/year.

Small Systems World

Journal for users of small computers, monthly. Hunter Publishing, Co., 950 Lee St., Des Plaines, IL 60016, 312/296-0770, subscription: $30/year.

Professional Journals for Microcomputers

ACM SigSmall--Small Computing Systems and Applications ($7/year).

ACM SigMicro--Microprogramming ($6/year).

ACM SigGraph--Computer Graphics ($10/year)

Distribution depends on special interest group; Association of Computing Machinery (ACM), P.O. Box 12114, Church Street Station, New York, NY 10249, 212/265-6300, ACM membership: $40/year, subscription price for members for each publication listed above.

Computer

IEEE Computer Society; 10662 Los Vaqueros Circle, Los Alamitos, CA 90720, IEEE membership: $46/year, publication is $6/year.

Microprocessor and Microsystems

Ten issues a year. IPC Science and Technology Press, 205 E. 42nd Street, New York, NY 10017, 212/867-2080, subscription: $143/year.

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US Military Academy 10966
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Fitzsimons AMC 80240
Walter Reed AMC 20012

INSCOM - Ch, Instl. Div.
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MDW
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Ill ; Construction Engineering Research Laboratory, 1984.
p. (Technical report ; P-146 (revised)

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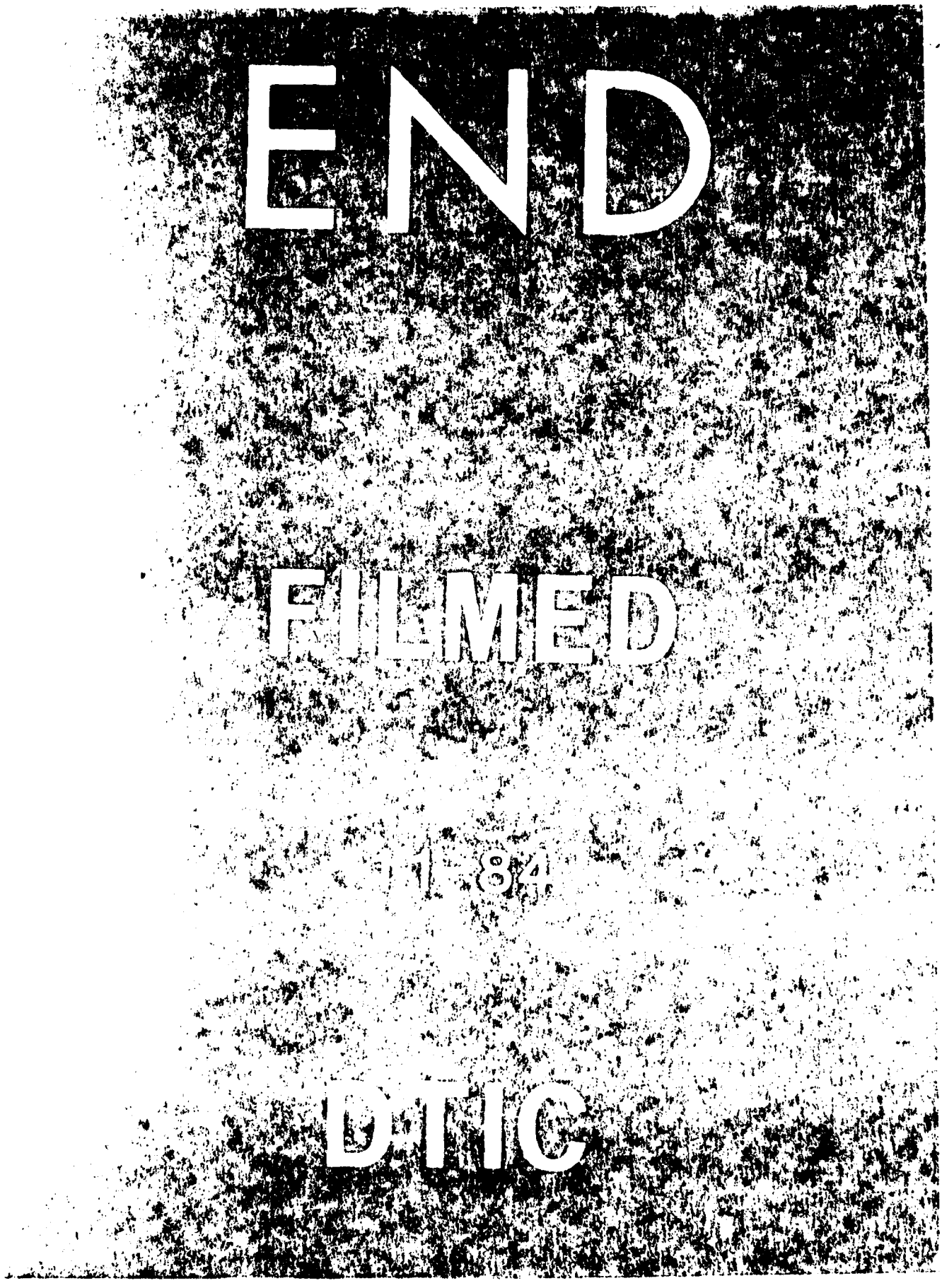
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